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A Self-Dumping Barge.*

By A. F. WIKING.†

The problem of dumping stone and dirt into the water is particularly of interest in Stockholm, where blasting goes on all the time in the work on extensions of the harbor and streets. A good many designs for automatic dumping barges have been suggested, but none has come to a trial except the one hereby presented. Of course the common hopper barges with doors in the bottom have been largely used.

The accompanying figures show a new type of barge designed by the writer. The mode of dumping is new, so far as the writer is aware, and has had its natural development on account of the large quantities of rocks which must be dumped in the waters about Stockholm. The common hopper barges with flaps in the bottom have not proved suitable for this particular work. The city authorities, therefore, up to this time, have exclusively used barges with ridged decks and flaps along the side. The dumping has been by hand power, though helped by inclination of decks.

When the design shown in the accompanying figures was fabricated in steel and tested, it worked so successfully that no alterations whatever were necessary.

The barge has taken on a load of 200 to 220 tons and dumped it without any hitch whatever, and is doing so continually. It takes twice as much load as the ridge-deck barges, costs only 3/5 as much as two such barges and saves the wages of 6 to 8 laborers. Of course, if the load was gravel or material suitable for the common hopper barges, the saving in working would not be as large as above. In such a case, however, one has to reckon with a much larger initial cost for hopper barges and with heavier outlay for maintenance. In this new barge the hull is not exposed to the attack of the cargo, which is delivered on a flat deck of ample dimensions. The deck is protected by a timber flooring which is easily and cheaply replaced.

Fig. 2 shows the general features and lines of the design. Fig. 3 is a cross-section of the hull. The operation is as follows: The tank "A" is filled with water (about 6 tons for a deck load of 200 tons in the actual design shown). The tank "B" contains compressed air at about seven atmospheres pressure. The tank "C" is at first empty but open to the air through the pipe "a." The tank "A" is in open communication with the upper cylinder "D" by the pipe "E." The tank "A" is also connected by an air pipe "b" to a valve box "F." The compressed-air tank "B" is connected to the valve box by the air pipe "d." While the tank "C" is always open to the free air through the pipe "a," yet it connects by the pipe "f" and valve "g" to the main pipe "E" going from the water tank "A" to the elevated tank "D." The tank "D," it will be seen, is always in open communication with the water tank "A" and the free atmosphere by the pipe "h."

The valve box contains a slide-valve mechanism which may be given four successive arrangements by successive pulls on a small line running from the barge to the towing vessel. These operations of the valve mechanism change the weight distribution on the barge so that it is dumped and returned to normal position merely by pulls on the dumping line.

The load is placed on deck, which has bulwarks on three sides. The fourth side (that one below the cylinder "D") must have only a low ridge "k" —Fig. 3, or doors to be opened by the pressure from the load on the inclined deck. For loads of rocks even the ridge is not wanted—a smooth deck is needed.

After the barge is loaded and towed to the dumping place, the operating line is carried over to the towing vessel. By the first pull on the cord, compressed air is admitted to the tank "A" and the water is forced up into the cylinder "D," so that the barge loses its equilibrium. It then tips until the rocks slide off. A second pull on the cord shuts the supply of compressed air off from the tank "A" and connects the latter to the free atmosphere.

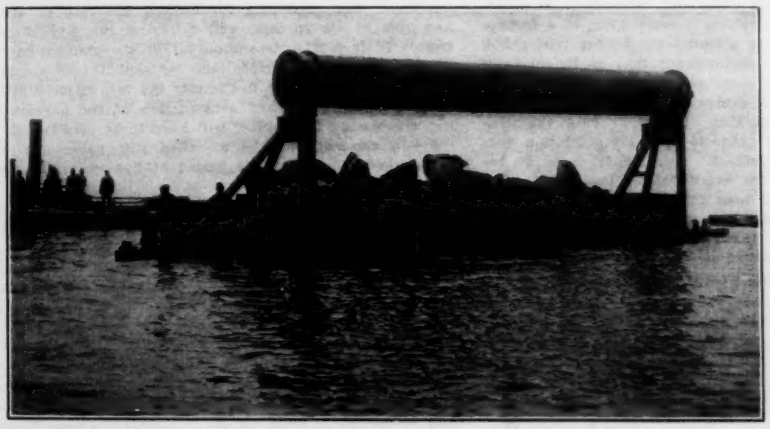
If the load slides off before the upper tank "D" reaches the water, then at the second pull on the operating cord the water drains from "D" back to the tank "A." If the tilting has been complete so that "A" is not lower than "D," then by a third pull on the cord the water in "D" is drained off to the intermediate tank "C," which is always lower than "D." To effect this the valve-box mechanism throws into gear the lever "m," shaft "r," lever "n," connecting rod "p" and the valve "g." The barge rises and soon is upright and the water in "C" (with any not drained from "D") flows back into the tank "A." A fourth pull on the cord restores the valve mechanism to its original position, as before the dumping. The pipe "X" is for sounding the liquid in tank "A." As none of this water ballast is lost in operating, glycerine is mixed with it to prevent freezing in cold weather.

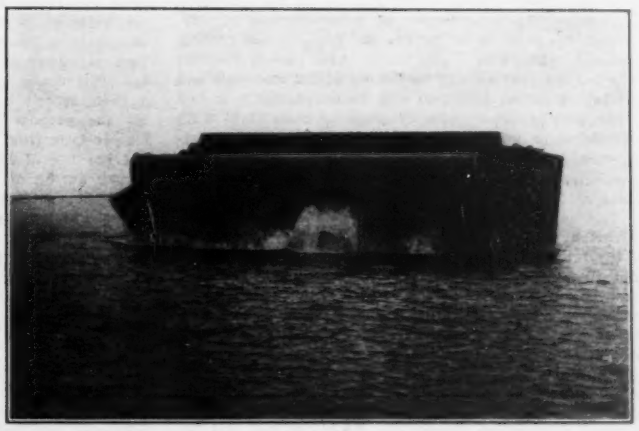
Compressed air is fed to the tank "B" by a hose connection and shut-off valve at the valve box. About 2 cu. m. (71. cu. ft.) of compressed air are necessary for a single dumping. The cost is small. Here it costs some 50 öre, or about 12 cts., if obtained from a shop installation for pneumatic tools. A small compressor, worked by an oil engine may be placed on one tug and used for all the barges of a fleet.

The illustrations on this page show a barge delivered to the city of Stockholm, where it is in daily service.

In comparing this barge with the common hopper barges with false bottom it appears that it is cheaper in first cost and will be cheaper in maintenance, that it accommodates rocks of practically any size and weight within its total capacity, that it is a first class craft for any harbor transport.

If required, the upper cylinder may be unshipped in a couple of hours. Of course, the barge





A WIKING SELF-DUMPING BARGE IN OPERATION.

[*We are informed that arrangements for the construction of the Wiking scows for the United States, Canada and Central America have been made by the Norborn Engineering Co., whose offices are at Eleventh and Market Sts., Philadelphia, and 1825 Park Row Building, New York City.—Ed.]

†Engineer, 63 B. Sluseplan, Stockholm, Sweden.

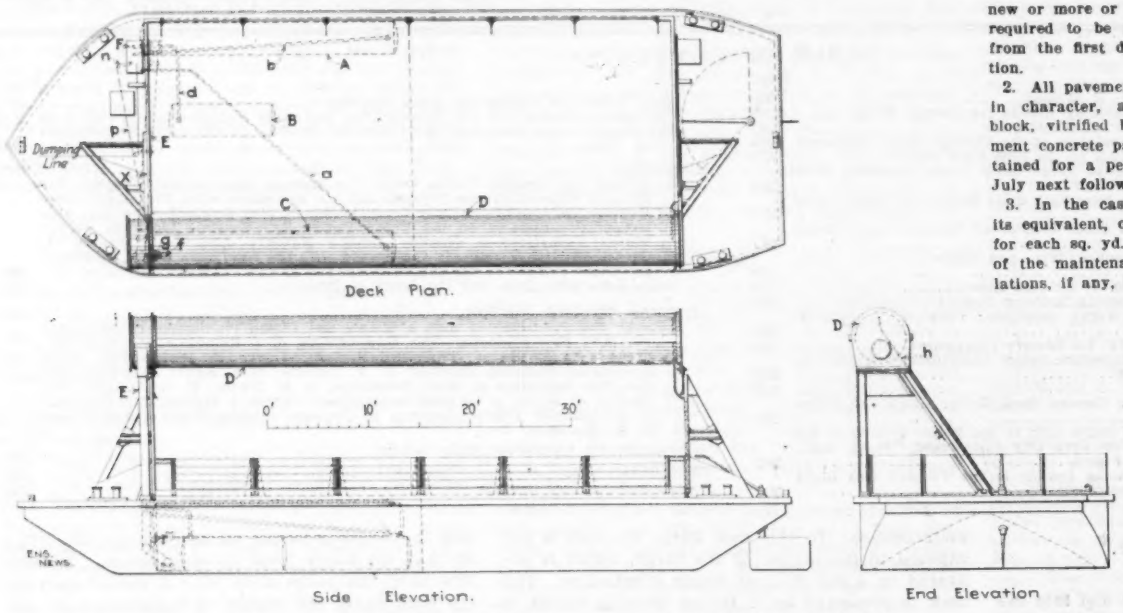


FIG. 2. PLAN AND ELEVATIONS OF A SELF-DUMPING BARGE.
(Designed by Mr. A. F. Wiking, Stockholm, Sweden.)

need not necessarily be as clumsy a construction as shown by the drawings. But when the distance of towing is short, fine lines merely cost money without having accompanying advantages. The breadth must always be sufficient to counteract the influence of high winds.

Bonds and Guarantees and Uniform Bidding Blanks for Paving Work.*

UNIFORM BIDDING BLANKS.—The practices of various cities in the preparation of their bidding sheets vary materially. Some cities include in the pavement proposition the construction or reconstruction of subsurface drainage, some include the grading and curbing required, while others provide in their paving contract only for the grading and furnishing of the materials and the laying of the pavement and its foundation.

The only practical value of adopting a standard form of bidding or proposal blanks would be to enable engineers to compare on a uniform basis the prices asked by contractors for the same kind of work in various parts of the country. Even the practical value of this is doubted, since the prices of labor and materials vary so much in different parts of the country that even if the proposals were based upon standard specifications and uniform bidding blanks, the conclusions reached upon comparison would be unreliable and misleading. The committee has therefore concluded to recommend that the convention take no action in this matter unless it be to continue it as a matter of further consideration by the permanent committee.

BONDS AND GUARANTEES.—The practice of providing for the maintenance of pavements upon completion and requiring a guarantee to insure the faithful execution of the obligation is common to all cities.

The period of such maintenance and the methods of guarantee are widely different. Ten years of maintenance are still insisted upon in some cities for all classes of pavements, five years for soft pavements and three years and one year for the hard pavements are required in others. In Baltimore the City Engineer, Mr. Fendall, has recommended to his City Council (without the prospects of adoption) that maintenance periods be eliminated altogether from their contracts, because he believes that unnecessary amounts are being paid out for maintenances and that it is practicable to establish and operate a system of inspection that will afford every reasonable and necessary assurance that the contract in all respects, both as to materials and labor, has been properly executed.

The usual practice to insure the faithful performance of the contract to maintain the pavement for a given period is to resort to a guarantee bond. In the majority of cases this bond is required to be that of a bonding company, although since the bonding companies have declined to write ten-year risks, those cities asking for ten-year guarantees have been obliged to accept personal bonds for five years of the period. Until recently this practice was general, but experiences related by several of the cities and referred to hereinafter, have led to the adoption in some cases of a further safeguard to insure the maintenance of the pavements. This safeguard is the requirement that at the close of the construction work there shall be left with the city a cash deposit or its equivalent, which may be used for the purpose of making repairs in case the contractor fails from any cause to meet his obligation during the life of his contract. The money is to be returned during or at the expiration of the period, provided the contract has been fulfilled.

In the majority of cases brought to our attention, both the cash reserve and the guarantee bond are required to be given, with the object of doubly insuring the proper maintenance. In New Orleans alone for the past 1½ years the use of maintenance bonds has been abandoned because in every case of default it was not possible to recover on the bond. Instead, a cash reservation, equal to 15 cts. per sq. yd. in the residential districts and 25 cts. per sq. yd. in the business districts, has been made to guarantee the maintenance.

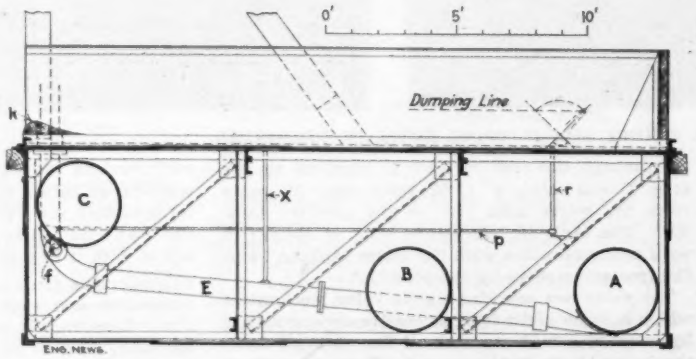


FIG. 3. CROSS-SECTION OF HULL, WIKING BARGE.

Taking into consideration all the facts brought to our attention, we have concluded to make the following recommendations:

1. All pavements, any portion of which is constructed of materials of a perishable nature, among which we would include, asphalt, bitulithic or bituminous macadam and wood block, or other pavement requiring special equipment to lay and maintain, and also such pavements that are of a patent or proprietary nature, new or more or less experimental in character, shall be required to be maintained for a period of five years from the first day of July next following the completion.

2. All pavements composed of materials more durable in character, among which we would include stone block, vitrified brick, and well-established Portland cement concrete pavements, shall be required to be maintained for a period of one year from the first day of July next following the completion.

3. In the case of all pavements, a cash deposit, or its equivalent, of 10% of the contract price per sq. yd. for each sq. yd. of pavement be retained for the whole of the maintenance period, said sum with its accumulations, if any, to be paid in full to the contractor if he fulfills the terms of his guarantee. The reservation is to be subject, however, during the maintenance period, for use by the city in making such repairs as are necessary and have been neglected or ignored by the contractor. In the latter case the balance of the fund, if any, shall be returned to the contractor at the end of the maintenance period.

4. If the bonding companies will offer a uniform and standard form of guarantee, satisfactory in form and cost to the cities, members of this association, which will protect the cities as amply and accomplish the purpose of keeping the pavements in repair as fully as may be done by the cash reserve plan, a guarantee bond in twice the amount of the established cash reserve may be accepted in lieu thereof.

5. In case of a satisfactory adjustment in the guarantee bond plan and its adoption by this association, it is further recommended that any default on the part of any bonding company in any of the cities of this association shall be reported to its secretary, and it shall be his duty to report to each of the said cities an account of such default.

Our conclusions with respect to the period of maintenance of pavements like asphalt are based on the theory of the execution of the construction under specifications permitting the contractor to use his own judgment between certain limits in manufacturing the pavement, thus assuming for himself the responsibility and risk of its success, and relieving the city therefrom. If it is the determination of the convention to adopt close-drawn specifications for asphalt and similar pavements, taking over to the city the full responsibility for the manufacture and construction of the pavement, our views upon the subject will have to be modified.

A.—In the case of the so-called soft pavements we recommend a maintenance period of five years, for the following reasons:

1. It is deemed necessary on account of the nature of the materials used and the method of manufacture, to require that length of time to fully demonstrate that the original work was executed strictly in accordance with the specifications and to develop defects in materials or workmanship.

2. The variation in the sizes and resources of the several cities, and the impracticability of establishing and maintaining in each the expert, technical and practical service, as well as the special apparatus and equipment to properly inspect an original construction and subsequently maintain it.

3. A longer period is not required for any practical purpose, and imposes on the taxpayer in advance the cost of maintaining the pavement during a period too remote and under conditions too speculative to permit a proper estimate of the cost to be made in advance. It is believed to be a better business proposition to save to the taxpayer the money which may be required for maintenance subsequent to five years, until it is demonstrated that it is needed for the purpose.

B.—In the case of the more durable pavements we recommend a maintenance period of one year only, for the following reasons:

1. The nature of the materials used and the work of construction are easily and readily specified and inspected, and all defects of workmanship and of material will be developed in the period recommended.

2. The materials required for repairs may be purchased in the open market under competition, and the work done with the ordinary tools and appliances and skilled labor at hand.

3. The repairs required upon this class of pavement amount to little or nothing during a number of years of its life; in fact (and as a rule) none until such time as the whole surface is in a condition to require repaving. The taxpayer may as well be saved the expense imposed by a requirement to maintain from which he obtains no service or other return.

C.—We recommend the adoption of a cash reserve in place of the present bond written by the bonding companies, and in place of the double provision of a cash

*Report of the Committee on Bonds and Guarantee, presented at the first meeting of the Organization for Standardizing Paving Specifications, held at Chicago, Feb. 21-26. The committee was composed as follows: W. T. Hardee, New Orleans, La.; Henry C. Allen, Syracuse, N. Y.; Geo. H. Norton, Buffalo, N. Y.; C. A. V. Standish, Chicago; A. C. Kugel, Omaha, Neb.; Charles E. Norton, Grand Rapids, Mich.; Robert W. Goodnow, Kansas City, Mo.

serve together with a like bond, for the following rea-

In the first of the above instances, it has been ught to our attention that in several of the cities ulted, some of the bonding companies have refused ake good the default of the contractor, and upon xpenditure of the money by the city pursuant to terms of its contract to carry out its provisions, contested the demand of the city to be reimbursed lemonstrated in court the insufficiency of its guar- by its success in the proceeding. We believe that cost of the guarantee eans of the cash reserve be less than that re- d to provide a guarantee and that the difference ld be saved to the yer. Again, it is essen- and of prime importance repairs should be de when they are need- and by the adoption a cash reserve scheme, is object may be accom- lished, and law suits, if they must come, carried on while the pavement is in good and safe condition.

2. In the second of the above instances, if the cash reserve scheme is sufficient to accomplish the desired object of keeping the pavement in good repair for the period specified, and we believe it is, the further requirement of furnishing the bond is superfluous, and adds just so much unnecessary cost to the work, and to the taxpayer, and consequently should be dispensed with.

There should be a more definite determination of conditions to be fulfilled under the maintenance and its guarantee. Such requirement should be special for the various kinds of pavements, but should be definite as to the condition requisite for the acceptance of the work and release of the guarantee. We recommend that the committees considering specifications for the various classes of pavements include in their work the definition of condition of pavements which should be required for maintenance under the guarantee furnished.

A Locomotive with the Cab Over the Pilot.

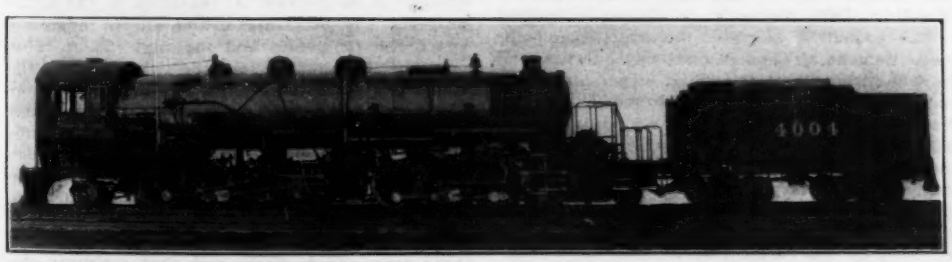
In our issue of April 29, 1909, we illustrated and described the large Mallet compound locomotives constructed by the Baldwin Locomotive Works for the Southern Pacific Co. The same builders have recently completed 15 additional locomotives for the Southern Pacific, which are practically duplicates of those which we previously illustrated, except that they are designed to run with the cab foremost, as shown in the accompanying views. With the locomotives first delivered, the enginemen complained that their view of the track ahead was greatly interfered with by the huge boiler. To obviate this difficulty, it was decided to run the locomotives backward. Very few changes were required to do this, the principal one being to attach the pilot to the rear end of the frames instead of the front, and arrange for the coupling of the tender to what would ordinarily be the front end.

Some of our readers may puzzle over the question, how the locomotive can be fired with the tender attached to the engine at the end opposite the fire-box. With coal burning, this would manifestly be impossible. But the locomotives on the Southern Pacific burn oil fuel, and it is simply a matter of carrying the oil pipe from the tender tank past the driving-wheels to the oil burners in the fire-box.

The advantages gained in the way of a clear outlook, by placing the cab at the extreme front of the locomotive over the pilot, are so great that it is rather strange so few locomotives have ever been designed in this way. The only one we now recall is a high-speed express locomotive which was exhibited at the Paris Exposition of 1900. The separation of the engineer from the fireman is of course a valid objection to the placing of the engineer's cab at the extreme front end on an ordinary coal-burning locomotive. The two are already separated, however, in many large locomotives where the engineer's cab is placed over the center of the boiler. Another reason against placing the cab at the extreme front end of the locomotive is the added danger to the engineer in case of derailment or butting collision. This would be partially offset, however, by his greater safety in case of rear collision.

The general dimensions of these Southern Pacific locomotives correspond closely to those of the earlier engines described in our issue of April 29 last. We may note here, however, that the total weight of the engine is 437,000 lbs., of which 394,700 lbs. are carried on the driving-wheels. The loaded tender weighs 172,265 lbs., making a total for the engine and tender of 609,265 lbs., or 304.63¼ tons. The total heating surface of the boiler is 6,393 sq. ft. The maximum tractive power, computed at one-quarter of the weight on the driving-wheels, is 98,675 lbs., and the tractive power working when compound, computed by the Baldwin Locomotive Works formula, is 94,640 lbs.

VIEW OF FRONT END OF MALLET COMPOUND FOR THE SOUTHERN PACIFIC RY., WITH CAB OVER PILOT.



MALLET COMPOUND LOCOMOTIVE FOR THE SOUTHERN PACIFIC RY., DESIGNED TO RUN WITH CAB IN FRONT.

Methods of Municipal Control and Regulation of the Chicago Street Railways.

After some 25 years of controversy between the city, the public and the street railway companies of Chicago, the city in 1907 secured the passage of what are known as the "traction settlement ordinances," and secured also their acceptance by the companies. Under these ordinances the companies operate practically as licensees, the city receiving 55% of the net profits of the companies, besides reserving the right of purchase and requiring the companies to put their property in first-class condition. The controversies and negotiations which culminated in this arrangement are reviewed in this article. For a better understanding of the whole subject the review is prefaced by a brief account of the history of the street railway franchises and systems of Chicago and of the efforts to secure municipal ownership which finally gave way to the settlement with the companies. The historical matter is followed by a summary of the principal provisions of the settlement ordinances, which are of a very unusual character. This summary is followed, in turn, by abstracts of papers presented before the Western Society of Engineers, relative to the ordinances themselves and to the board of engineers under which their requirements are carried into effect.

History of the Chicago Street Railways and Franchises.

In view of the developments in this case and of the exceptional character of the control exercised by the city, it will be of interest to review briefly the history and growth of the Chicago electric railway system as it now exists. The history is given very fully in the first report (1909) of the Board of Engineers created by the new ordinances. The first ordinances for street railways were passed in 1856 and 1858, but nothing was done under the former and the latter was vetoed by the mayor as granting a perpetual franchise if the city did not purchase the lines at the end of 25 years. In 1858, a third ordinance was passed, with a grant of 25 years and provision for purchase by the city. This was contested on the ground that the city council had no right to grant the use of the streets for railway purposes, but in 1859 the legislature passed an act incorporating the Chicago City Ry. Co. and affirming its rights to the use of the streets named in the franchise. The same act provided for the incorporation of the North Chicago Street Ry. Co. It named no streets (leaving this to the city council), and the rights granted in the city and county were for 25 years.

In 1861, the Chicago West Division Ry. Co. was incorporated. Its charter prohibited it from constructing or using any lines on the north side of the city without consent of the North Chicago City Ry. Co., but permitted it to "acquire or enjoy" any rights granted to the Chicago City Ry. Co. on the south and west sides. Under the latter provision, the West Division Ry. Co. in 1863 purchased all of the Chicago City Ry. Co.'s right in streets on the west side.

Thus as early as 1863 the city was partitioned into three districts by the street railway companies, and an agreement was made between them to protect the interests of each. The original ordinances to the Chicago City Ry. provided for a 5-ct. fare for a ride of any distance within the city limits, but this provision was disregarded, and each company charged 5 cts. for a ride on its lines. This led to disputes and finally the matter was taken into the courts, with the result that the Chicago City Ry. Co. (operating on the south side) was compelled to issue and accept transfers between lines operating on the north and west sides.

The cable traction system was put in service by the Chicago City Ry. on the State St. and Cottage Grove Ave. lines in 1882; the North Chicago City Ry. Co. began its use in 1886, and the West Division Ry. in 1888. In 1893, the Chicago City Ry. Co. began the introduction of electric traction on the overhead wire system, in

order to facilitate the handling of traffic for the Columbian Exhibition. Its example was followed by the other lines, and by 1896 a majority of the horse-car lines had been equipped for electric traction. The "traction settlement" ordinance passed in 1907 and now in force, required the elimination of cable conduits, but the cable traction system had been abandoned finally in 1906, as noted in our issue of Sept. 20, 1906.

In 1886 and 1887, control of the west side and north side companies was acquired by speculative financiers, who proceeded to organize various independent companies for the building of new lines which were properly extensions of those of the original companies. The dilapidated condition of the property of the original companies, the inferior service, and the various complications which followed the financial manipulations, tended largely to the development of a public agitation of such force as to overwhelm eventually all the street railway corporations of the city.

During the disputes over the companies' operations and over the question of municipal ownership there had been a bitter controversy as to the term of expiration of a number of franchises granting rights for certain streets. Some of the old ordinances were very indefinite in this respect. The "99-year" act passed by the legislature in 1865 (over the governor's veto) extended the life of incorporated companies to 99 years. In 1870 a new state constitution went into effect which provided that the legislature should pass no law granting rights to street railway companies without the consent of the local authorities, and in 1874 an act was passed providing that such consent should not be given for a period of more than 20 years. In 1875, the city adopted a new charter which authorized the city to permit the construction of street railways, but limited such permission to a term of 20 years.

In 1883, the older ordinances began to expire, and the complication as to franchise rights began. The State act of 1874 and the city charter of 1875 (noted above) governed ordinances granted subsequent to their adoption, but there was a question as to the effect of the "99-year act" upon the original grants. A compromise was effected for the time being, and an ordinance was passed granting the three companies an extension of time to July 30, 1903, upon all their existing lines. The ordinance also established an annual license fee of $50 for each car operated 365 days.

The Humphrey bill of 1897 proposed to extend the power to grant franchises from 20 years to 50 years, and to extend every street railway ordinance then in force for 50 years from September, 1907. This was defeated, but instead there was passed the notorious Allen law which was designed to give very material advantages to the Chicago companies, although ostensibly applying to other cities. It permitted non-competing companies to consolidate, and practically excluded all competition by requiring any company wishing to use the tracks of another (where new lines were impracticable in the business district) to secure the consent of the latter. It also permitted the granting of franchises for 50 years. In relation to this law, various ordinances were introduced in the companies' interests, but in 1899 the legislature (on demand of the city) repealed the Allen law, and thus put the 20-year franchise limit again in force.

After protracted legal proceedings the dispute over the franchise limitation under the "99-year act" reached the U. S. Circuit Court. In 1904, Judge Grosscup sustained the act, and held that its effect was to extend for 99 years the companies' franchise rights for the lines which had been authorized by the ordinances prior to the adoption of the new city charter in 1875. This gave the companies a position of considerable power. In 1906, however, the U. S. Supreme Court reversed this decision, holding that while the law extended the companies' corporate life for 99 years, it did not extend the duration of their rights in the streets. This decision gave the city practical control of the situation and greatly facilitated the settlement of the dispute.

During the period of active controversy over the franchise terms and renewals the property was allowed by the companies to deteriorate to a notorious extent. The rails and tracks were rough and worn out, breaks in the traction cables were frequent, the rolling stock was antiquated and dilapidated, and the service was inadequate. The reason given for this on the part of the companies was that with the expiration of franchises in sight the companies could not afford to put any money into improvements. There was the implication that if the city would grant the desired renewals or extensions the properties would be put in first-class condition and adequate service would be given. The public, however, declined to accept the implied proposition, but demanded that the city should compel the companies to improve the property and the service, and this is what was finally done.

In December, 1899, the city council passed a resolution providing for a special street railway commission. This commission made a report in December, 1900, and on its recommendation a council committee on local transportation was created. In April, 1902, the first vote on municipal ownership was taken: for, 142,826; against, 27,998. In 1902, Mr. B. J. Arnold was engaged as engineer by the city, to report on the street railway situation. A special feature of his report (1902) was the recommendation that the city should be regarded as a unit (instead of the three separate divisions of the north, south and west sides), and that routes through the business district should be substituted for the terminals in that district.

In 1903, the agitation in favor of municipal ownership of the street railways became prominent and aggressive, and continued as an important factor in the subsequent negotiations between the city and the railway companies. In 1904, a vote was taken as to the adoption by the city of the provisions of the Mueller law (1903) which authorized cities "to acquire, construct, own, operate and lease street railways, and to provide the means therefor." There were three specific questions under vote, and all of them received a majority of favorable votes. The questions were as follows: (1) Shall the Mueller law be adopted and put in force in Chicago; (2) upon the adoption of this law shall the city proceed to acquire ownership of the street railways; (3) shall the city, instead of granting franchises, proceed at once under its police powers and existing laws to license the street railway companies until municipal ownership can be secured, and compel them to give satisfactory service. In April, 1905, another popular vote was taken on the granting of franchises to street railway companies and it was voted by a large majority (approximately 59,000 to 152,000) that the council should not pass any ordinances granting franchises to any street railway companies. About this time the city proposed to organize a municipal system from lines of companies whose franchises had expired (Eng. News, June 8, 1905), but nothing came of this plan.

In July, 1905, Mayor E. F. Dunne submitted to the council a so-called "contract plan" for the settlement of the street railway question and the establishment of municipal ownership. This plan provided for a body of trustees which should construct a municipal system of street railways on behalf of the city, and then hold and operate this system until the city could complete the necessary procedure to acquire and operate it. This was referred to the council committee on local transportation, but was not approved by the committee.

In January, 1906, the council passed an ordinance (proposed by Mayor Dunne and recommended by a minority of the above committee) providing for the issue of $75,000,000 in bonds, under the Mueller law, for the acquisition of street railways by the city. This was carried by popular-vote majority of 3,837, but in 1907 the Supreme Court of Illinois rendered an adverse decision to the effect that the special certificates authorized by this law would constitute a debt of the city, and that the city could not issue such certificates as it had then reached the constitutional limit of its indebtedness. This decision conclusively disposed of the adoption the Mueller law.

At the same popular election two other questions were voted upon: (1) should the city proceed to operate street railways; (2) should the city proceed without delay to secure municipal ownership and operation of all street railways instead of passing the pending franchise ordinances or any franchises to private companies. The second was carried. The first received a small majority, but not enough to carry it.

Under the potent influence of the court decision of 1906, adverse to the companies' claims as to the duration of their franchises, the controversies between the city and the street railway companies culminated fortunately in negotiations for determining some basis of agreement between them, covering the various points at issue. These negotiations were commenced early in 1906, through the council committee on local transportation. At the same time, the city appointed a commission to prepare a valuation of the properties of the railway companies.

In January, 1907, the committee on local transportation made its report and submitted two ordinances based upon agreements effected between the committee and the companies. These ordinances wiped out all existing franchises, and provided for the following essential features: (1) the rehabilitation of the railway lines, by the companies, but under the direction of the city; (2) the right of the city (or its licensee) to purchase the system on giving six months notice, and upon definite terms fixed by the ordinances. The ordinances were passed by the council in February, 1907, subject to the approval of the voters at the April election. Mayor Dunne vetoed them, but the council (on Feb. 11, 1907) passed them over his veto by a vote of 57 to 12. At the election, they were carrried by a vote of 167,367 to 134,281. They were accepted by the street railway companies. This was the final step of the negotiations, and effected a basis for harmonious relations between the companies and the city to the benefit of the public. The vote was specifically on the following question:

> Approval of the ordinances authorizing the Chicago City Ry. Co. and the Chicago Railways Co., respectively, to construct, maintain and operate street railways in the city, and providing for the purchase thereof by the city or its licensee.

One of the ordinances related to the Chicago City Ry., and this was promptly accepted by that company. The other related to the Chicago Union Traction Co. (now the Chicago Railways Co.) but its acceptance was delayed until January, 1908, owing to the financial complications and litigations in which the company was involved. In 1908, ordinances on the same general lines were passed for the Calumet & South Chicago Ry. and the Southern St. Ry., the latter being operated by the Chicago City Ry. These four railways have in all about 650 miles of single track, of which 300 miles are included in the scheme of reconstruction.

In brief, the system which is now in effect in Chicago is as follows: A valuation of the entire property has been made, and agreed upon between the companies and the city. There is no question of franchises, but the city has given the companies what is practically a license to operate; reserving, however, the right to purchase the property on the agreed valuation (plus subsequent expenditures). The city exercises supervision of all financial matters, and requires the payment to it of 55 per cent. of the net receipts. The companies are required to improve and practically reconstruct their property within three years (from 1907), and then maintain the property in condition under the direction and supervision of a permanent board of engineers composed of representatives of the city and the companies. Up to the present time (and covering two years) the expenditures on improvements have amounted to about $30,000,000.

Details of the ordinances follow.

Summary of the Traction Settlement Ordinances.

(1) The city and the companies have agreed upon a valuation of the tangible and intangible property of the latter. This value is $21,000,-

for the Chicago City Ry. and $29,000,000 for Chicago Railways Co.

(2) The companies are required to proceed at once to rehabilitate and re-equip their systems, and put them in first class condition. This to be done in compliance with the specifications of and under the supervision of a Board of Supervising Engineers, created by the ordinances.

(3) The city (or a company authorized by it) has the right to purchase (upon six months notice) either or both of the street railway systems upon the payment of the agreed valuation and the cost of rehabilitation and extensions, including fair allowance for construction, profit and brokerage. If they are to be so acquired for operation by a private corporation for its own profit the purchase price is to be increased 20 per cent. If the city does not purchase within 20 years (or by 1927) it has the power to designate a licensee to purchase and operate the lines upon the same terms at which the city could acquire them.

(4) The companies are limited (during their operation) to an interest return of 5 per cent. upon the agreed value of their property, plus the cost of rehabilitation and extensions. The net profits from operation are to be divided in the proportions of 55 per cent. to the city and 45 per cent. to the companies. Of the gross receipts, 6 per cent. to be set aside for maintenance and repairs, and an additional 8 per cent. to cover renewals and depreciation. The books and accounts to be kept in a manner approved by the city comptroller, and annual reports and audits to be made.

(5) Certain extensions are provided for, and the companies agreed to build additional extensions each year (after the third year), amounting to six miles of double track (or 12 miles of single track) for the Chicago City Ry., and four miles of double track (or eight miles of single track) for the Chicago Rys. Co.

(6) Trains of cars were prohibited after one year (from 1907), and within three years the Chicago City Ry. and the Chicago Rys. Co. were to have in operation respectively 800 and 1,200 double-truck cars of modern type.

(7) The companies must grade, pave, repair, sprinkle, sweep and keep clean and free from snow the parts of the streets occupied by them (or the entire width of street if required), and must remove refuse in cars at night, if so required.

(8) After the three-year period of reconstruction and reequipment (following the passage of the ordinances) the companies must expend each year for maintenance and repairs a sum at least equal to 6 per cent. of the gross receipts for that year. If this is not done, at the end of the year the amount must be turned into a special fund for use when such repairs or maintenance became necessary.

(9) Where grants to the two companies cover the same part of any street, these are construed to be for a joint use of the tracks, and the expense of construction, maintenance and operation will be divided equally.

(10) The fare for a continuous trip in one general direction within the present or future limits of the city is to be 5 cts.; 3 cts. for children under 12, and no fare for children under 7, who are accompanied by persons paying fare. A comprehensive system of transfers is provided for (including transfers between the lines of both companies).

(11) Through routes extending across the city, and including the lines of both companies, are provided for in order to reduce the congestion and lack of public convenience incident to the terminating of lines in the business district.

(12) The tracks must be laid with grooved rails, and the track construction and paving are subject to the approval of the Board of Supervising Engineers.

(13) The motive power must be electricity, and after three years from the passage of the ordinances the city may require the use of the underground trolley system. The city has the right to use the poles (without compensation) to carry its signal, telephone, telegraph and electric wires and lamps. The cable tracks were required to be removed.

(14) All feeder and transmission lines to be laid underground in a specified district which covers about 40 sq. miles. This requires the installation of about 6,500,000 duct-feet of underground conduit.

(15) The Chicago Railways Co. agreed to lower and reconstruct the tunnels under the Chicago River at Washington St., LaSalle St. and Van Buren St.

(16) The companies agree to furnish funds, upon demand of the city, to the amount of $5,000,000 for the construction of a subway for street railways in the business district. This amount is to be independent of the cost of rebuilding the Chicago River tunnels. It is to be apportioned 40% to the Chicago City Ry. and 60% to the Chicago Rys. Co. The subway is to be built and owned by the city, and the plans are to be approved by the Board of Supervising Engineers. After its completion (but in not less than five years from 1907) the companies may be required to furnish additional sums for extensions.

The ordinances provide that the gross receipts of each company shall be distributed in the following manner:

(1) The operating expenses, including taxes.

(2) The ordinary repairs to the physical property for which a sinking fund is provided, the minimum of which shall be not less than 6% of the gross receipts per annum.

(3) Out of the gross net earnings remaining after deducting the above charges, the company may retain 5% upon the capital account as approved by the Board of Supervising Engineers.

(4) The remaining net earnings are divided 55% to the city and 45% to the company.

The immediate rehabilitation required by the ordinances to be done within three years from the acceptance of the ordinances covered the following work: (1) the removal of cable tracks, slots and conduits and the reconstruction of tracks as specified; (2) the reconstruction by each company of 60 miles (single track) of existing electric tracks to the specified plans; (3) the necessary distribution system and substations; (4) the rebuilding of the car houses; (5) the increase of the number of double-truck cars (as noted above); (6) the reconstruction of the three river tunnels of the Chicago Rys. Co. All this work was to be prosecuted as rapidly as possible and to be completed within three years from the acceptance of the ordinance.

The ordinances provided that upon their acceptance there should be organized a permanent Board of Supervising Engineers composed of three engineers; one appointed by each of the two companies, and a third member appointed by the city. Mr. Bion J. Arnold, M. Am. Inst. E. E., was named in the ordinances as the city's representative; he is ex-officio Chairman and Chief Engineer. Later Mr. George Weston, M. Am. Soc. C. E., was appointed Assistant Chief Engineer and a member of the Board as the city's representative. The other two members are Mr. Harvey B. Fleming, M. Am. Soc. C. E., Chief Engineer of the Chicago City Ry., and Mr. J. Z. Murphy, Chief Engineer of the Chicago Rys. Co. During the first three years (the period of "immediate rehabilitation") the salaries and expenses of the board form a part of the cost of the work; after that period, they will be regarded as operating expenses and paid out of gross receipts.

The Board has power to determine what work shall be treated as construction, reconstruction, equipment, re-equipment, extensions, new lines, or additions to plant or property to be paid for by the company out of the capital funds to be provided by it for that purpose; and also what work shall be treated as maintenance, repairs and renewals, to be paid for out of the companies' gross receipts from operation. This determination is governed by the following provisions:

During the three-year period of "immediate rehabilitation" 70% of the gross receipts shall be set apart and shall be used so far as required in defraying the operating expenses, including maintenance and repairs. The residue of this 70% shall be applied to the cost of renewals, and no part of the cost of any renewal paid for out of this 70% shall be charged to additional capital. All expenditures for renewals during the three years in excess of such residue of said 70% shall be charged to capital account.

After the three-year period of "immediate rehabilitation," the cost of renewals shall be paid as above provided. But such expenditures (and only such expenditures) as are made for the purpose of extensions of or additions to property shall be thereafter considered as additions to capital; provided, however, that in the replacement of any principal part of the property (either existing or hereafter acquired) there shall be charged to capital the excess amount that the new property cost over the original cost of the property displaced, excepting that the value of property contained in the appraisal inventory of the property of the company shall be used instead of first cost for all property listed in such appraisal inventory.

The Work Under the Street Railway Ordinances.*

By B. J. ARNOLD, M. Am. Inst. E. E.†

As a step to the establishment of the present ordinances, the city authorities deemed it necessary to value the properties of the street railway companies. A valuation commission was organized in 1906, and consisted of three members appointed by the city. They spent several months examining the properties, and finally submitted to the City Council a report which fixed the valuation at about $47,000,000 exclusive of the pavement, or about $52,000,000 including the pavement.

The valuation was given in this manner because there was a legal question involved. The companies contended that they were entitled to credit for the pavement, while the city contended that they were not entitled to such credit. The Council Committee on Transportation finally agreed upon $50,000,000 as a fair valuation for the property of the two companies: $21,000,000 for the Chicago City Ry. Co., and $29,000,000 for the Chicago Railways Co. (then the Chicago Union Traction Co.). These figures were accepted by the companies.

The ordinances provide that the properties shall be reconstructed under the direction of a Board of Supervising Engineers, and in accordance with plans prepared and approved by that Board. The companies are to be credited with the $50,000,000 valuation and with all additional money that is put into the properties in accordance with plans which must meet with the approval of the Board. Thus the city, in case it should get ready to purchase, knows the exact price of the properties at the time of the purchase, as no money is credited to capital account unless it is certified to by the Board, the certificates being filed monthly with the City Comptroller. There is thus always a record of the amount of money that has gone into the properties. The work of this Board among other things, is to certify (from month to month) the amount of work done during the previous month.

Under the ordinances, the railway companies agree to completely rehabilitate the properties and to furnish sufficient money to accomplish this purpose in accordance with the plans which this Board prepares. There is no limit to the amount of money that the companies are required to furnish, that question being left to the judgment of the Board.

This Board consists of four members, two of whom represent the companies, one represents the city, and the fourth represents both parties. When any question arises which affects only one company, that company has a full vote,‡ and the third man has the deciding vote, in case of a difference of opinion. There have been very few final differences, almost all questions having been decided by a practically unanimous vote. In case a question arises which involves the interests of both the railway companies, then the representatives of the railway companies have a half vote each. So that there is always one railway vote, one city vote, and one independent vote. The Board consists practically of three men when it affects the interests of any particular company, but when the two interests are affected, then there are four men who vote, but the two railway men then constitute one vote. That plan was provided in the ordinance in order that there might always be an odd vote on the Board.

Under the ordinances, the companies are required to largely reconstruct their systems within a three years "rehabilitation period." This rehabilitation of the properties has cost nearly $30,000,000 in the last two years. We have the remainder of this season (1909) for work with the Chicago City Ry., during which it will spend probably $2,000,000. The Chicago Railways Co. has yet two years to complete its improvements, so that there will probably be put into the properties, before we get through, somewhere between $35,000,000 and $40,000,000. We hope to get through within the latter figure, but we are not sure, as it depends upon whether we build power houses.

The ordinances provide that the railway companies shall receive a profit on this reconstruction work of 10% over and above the actual cost to the company. An additional 5% is allowed for securing the money (that being the ordinary brokerage), taking into consideration the discount on the bonds and other incidental expenses

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‡The representative of the other company not voting.—Ed.

toward securing it. So that the companies receive 15% over and above the actual cash used in the rehabilitation work, their net profit being 10%. They are furthermore required to set aside or spend upon the properties after they are once reconstructed, 6% of the gross receipts for maintenance or repairs.

In addition, they are required to set aside 8% of the gross receipts monthly, into a special renewal and depreciation fund, deposited in banks designated by the city. This fund remains in the bank unless drawn upon to replace principal parts of the property. For instance, if it becomes necessary to replace an old car with a new car, this fund is drawn upon for an amount equivalent to the value of the old car, and the difference between the cost of the new car and the cost of the old car is charged to capital account. The old car is sold; the amount of salvage from the old car is deducted from capital account. Thus capital account is only increased to the extent of the cost of the new car over the old car, less the salvage on the old car.

The ordinances were framed upon the theory that the city should be able to purchase the properties at any time, upon giving six months' notice to the railway companies. The price that the city would have to pay would be known by virtue of the valuation previously fixed ($50,000,000), plus the sum of the certificates issued by the Board up to the time of purchase.

In order that the city would be insured of a first-class railway system, or enough cash to put it in first-class shape, this renewal fund was established. After the rehabilitation work is completed, it is expected that the railway will be maintained to as high a point of efficiency and maintenance as a railway can be maintained. We have assumed, from the best information that we could gather, that it would be possible to maintain a railway at about 85% of its first cost. Before any large railway system is finished, part of it is worn out, consequently you can not maintain it at 100% of its original cost. But you can maintain it probably at about 85%, and this renewal fund is intended to maintain the property up to that point all the time. And that 85% is considered under the ordinance as 100% good, that being the highest point at which it is expected that this property can be maintained.

But suppose at the time of purchase by the city that the railway companies have not maintained the properties up to this 85%, then the difference between that value and the value at which they have maintained it, will be found in cash in this renewal fund, which will be taken over by the city at the time of the purchase. Thus the city will acquire a railway in first-class condition, or a railway in poor condition but with enough cash on hand to put it in first-class condition. This is a very wise provision.

The ordinances provide that out of the gross receipts of the companies, first shall come the operating expenses of the companies; then will come this renewal fund of 8% (including the 6% fund previously mentioned), after the operating expenses and these funds have been provided for, the companies receive 5% upon the amount of cash invested in the properties at the time of consideration, as evidenced by the Board's certification. After this 5% has been deducted, there remains a net balance. That balance is divided between the companies and the city in the proportions of 55% to the city and 45% to the companies.

When the ordinances were under consideration, certain persons (having the interests of the city at heart) requested that the ordinances should stipulate that this 55% of the net receipts should never be less than 10% of the gross receipts. After working out the probable results for the period of 20 years covered by these ordinances, we found that we could not recommend that the railway companies guarantee the city 10% of the gross receipts, and at the same time require them to build the kind of a railway that we (as engineers) said the city ought to have. The ordinances stipulating 55% of the net receipts were ratified by the people by a majority of 35,000. During the period covered by an estimate this percentage was approximately 8% of the gross receipts.

The supervision of the books of the companies is placed with this Board of Supervising Engineers. The Board has a large auditing staff; in fact it has auditors in the offices of each of the companies, supervising the books, or to see that the books are kept in accordance with the forms which have been originated by the Board and approved by the city comptroller. The auditors pass from one company to the other and check up monthly all expenditures upon which to base our certificates. During the reconstruction period, these certificates are based not only upon the books of the company, but also upon the reports of the assistant engineers. These engineers are inspecting the work simultaneously with the auditors' examination of the companies' books.

Each set of men sends reports into the office, and the heads of the departments make up their reports to a certain point, independently of each other. Then the reports are compared and if there is no discrepancy between the engineers' report and the auditors' report, they are assumed to be correct. If there is a discrepancy, it is analyzed carefully and made to harmonize before the certificate is finally passed by the Board and submitted to the comptroller. Thus we have two independent sources of assuring accuracy: (1) the auditing department; (2) the engineering department. We feel that the work is thoroughly and carefully done, and that it is accurate. Minor mistakes may creep in from time to time, but there is always a chance for correction, as we have 60 days to correct any certificate given.

Organization and Work of the Board of Supervising Engineers.*

By GEORGE WESTON†, M. Am. Soc. C. E.

Owing to the magnitude of the work to be undertaken, the working force was organized into divisions, each of which was placed in charge of an engineer who had specialized in that particular work. The divisions are as follows: (1) track and roadway; (2) electric power distribution; (3) buildings and fixtures; (4) power plant equipment; (5) cars and car routing; (6) tunnels and subways; (7) drafting, in charge of a chief draftsman; (8) accounts, in charge of a certified public accountant. They were organized about the middle of 1907, except that No. 6 was organized early in 1908. The working force of the chief engineer's organization comprises 137 persons, including engineers, accountants and office employees.

Each division engineer has inspectors, who, in addition to their other duties, render to him on forms daily, semi-monthly and monthly reports of the quantities and amounts of material used and hours of labor expended on each piece of work in progress. These reports are used by the division engineer as a basis for the monthly estimates and also as a check upon the expenditures made by the railway companies and reported by them to the division of accounts. Thus, a counter-check from two entirely independent sources is secured; from reports of the railway companies as checked and summarized by the division of accounts, and from the field reports of the division engineers.

TRACK AND ROADWAY.—Track construction work was commenced June 17, 1907, on Root St. (between Wallace and State Sts.) by the Chicago City Ry. Three types of track have been designed and approved by the Board, differing principally in respect to the foundation: (1) steel ties in concrete; (2) wooden ties in concrete; (3) wooden ties on a foundation of rolled broken stone, with concrete between and on top of the ties to provide a foundation for the paving. The tracks built by both companies consist principally of types No. 2 or No. 3, and the greatest mileage is of type No. 2.

ELECTRIC POWER DISTRIBUTION.—This covers underground conduits, underground and overhead feeders and transmission lines, trolley wires and connections, bonds, auxiliary cables and telephone systems. It includes also the testing of rail joints for relative conductivity.

BUILDINGS AND FIXTURES.—This division took up the inspection of the construction of substation buildings and fireproof car houses, plans for which had been made by the Chicago City Ry.; and it has cooperated with the Chicago Rys. Co. in the preparation of plans and specifications for similar buildings. The former company now has four large modern fireproof car houses capable of housing 1,076 double-truck cars, while the latter has five car houses housing 834 cars. The substations are of fireproof construction, with pressed brick walls, steel roof trusses carrying book-tile roofs and composition covering, and concrete floors with red tile surface.

POWER PLANT EQUIPMENT.—At the time of the organization of the Board of Supervising Engineers, the Chicago City Ry. Co. had in operation three steam plants (one operated only during the winter months) for the generation of electricity for operating its lines. This company also obtained a large amount of electrical energy from the Commonwealth Edison Co. through two rotary converter substations. Since then additional substations have been built and put in operation, and all of the current required for the operation of the railway is now purchased. The company receives at its substations, 25-cycle, 9,000-volt, three-phase current, generated at the Fisk St. power plant of the Commonwealth Edison Co., and delivers current at 600 volts to the direct-current feeder system of the road. Five substations have been estimated as required to supply the necessary electric current to the railway company. The total capacity of all the substations is 50,400 KW., exclusive of a storage battery rated at 2,240 KW. for one hour.

The Chicago Railways Co. had two steam plants generating direct current, and was converting the old Van Buren St. cable engine house to a substation taking current from the Commonwealth Edison Co. This latter has been enlarged, and three new substations built, while others will bring the total substation capacity to 44,000 KW.

CARS AND CAR OPERATION.—The standard type of car now adopted is of the prepayment type, seating 40 passengers. The car of the Chicago City Ry. Co. is 48 ft. 3 ins. long and 9 ft. wide over all. The platforms are 7 ft. 11 ins. long over all and 6 ft. 11 ins. long inside, affording large and commodious loading floor space. The Chicago Railways Co. is building 650 cars 49 ft. 2 ins. long and 8 ft. 9 ins. wide over all; length of vestibules, 8 ft. 4½ ins. over all.

Special attention has been given to lighting and heating. The lamps for interior illumination are placed over each seat, and have frosted globes. The heaters are electric, and special heaters are provided on the platforms. The cars are equipped with disappearing folding steps, thereby making it possible to have the non-loading side of the car closed, and no protruding steps or other parts to permit hitching on or standing on the outside. The cars are equipped with both air and hand brakes. The motor equipment consists of four 40-HP. motors.

Of the 650 cars under construction by the Chicago Rys. Co., 600 are of composite construction with steel underframes and wooden body, and are being built by the Pullman Co. The remaining 50 are steel cars being built by the Pressed Steel Car Co. To Mr. Bion J. Arnold is due the credit for the purchase of these steel cars, as he, in connection with his work on the New York subway problem, recognized the advantages to be gained by the operation of steel cars in subways rather than wooden cars. As we hope to have a subway in Chicago at some time in the future it was concluded wise to begin the study of the construction of steel cars and their maintenance, cost, comparative life, etc. In dimensions, interior arrangement and appearance these cars are identical with the others, but with the exception of the doors, car steps, trolley board, and maple floor strips, the cars are of steel construction and practically fireproof throughout.

TUNNELS AND SUBWAYS.—The ordinances require the Chicago Rys. Co. to rebuild the tunnels under the Chicago River at Lasalle St. and Washington St. Plans and specifications have been prepared for this work, which will include approaches so designed that the tunnels can be connected with the proposed subway system for street cars.

DRAFTING DEPARTMENT.—This is in charge of a chief draftsman, who has a clerk and four squad foremen. Each foreman is assigned to a special class of work, and has such draftsmen and tracers as are necessary. The chief draftsman receives instructions from the division engineers, and is called upon to supply all sketches and drawings required by the different divisions. All drawings are on sheets of standard sizes, which are multiples of the regular letter sheet (8½ × 11 ins.). These sizes are 8½ × 11 ins., 34 × 22 ins. and 34 × 44 ins. All drawings larger than 34 × 44 ins. are called "rolls," and are designated as "R" drawings. For convenience, each division has a classification letter which corresponds with that used in the classification of accounts by the American Street and Interurban Railway Accountants' Association.

DIVISION OF ACCOUNTS.—This has charge of checking all expenditures that relate to the cost of rehabilitation, of ascertaining (with the assistance of reports from the engineering division) whether or not such expenditures are reasonable, and of determining whether such expenditures are proper charges to capital account, in accordance with the rulings of the Board. It has to determine also whether proper reserves have been created and are maintained by the companies, as set forth in the ordinances. In addition it keeps account of all expenditures made by the Board in the carrying out of its duties, which expenditures, in accordance with the terms of the ordinances, are to be added to capital accounts of the railway companies during the period of rehabilitation, and after that period are to be charged to operating expenses.

Capital account money is new and additional money put into the property to improve and extend it, and is obtained from other sources than the cash receipts of the company.

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The Cleveland Street Railway Settlement On the Low-Fare Plan.

Cleveland has followed Chicago in bringing a long street railway controversy to a close by granting franchise extensions which continue private ownership and operation instead of venturing on municipal ownership. The history of the Chicago struggle and the terms of its settlement are given at length elsewhere in this issue. Below will be found an abstract of the Cleveland franchise ordinance, passed by the city council in December, 1909, and ratified by a vote of 27,307 to 19,197, at a referendum election on Feb. 17, 1910.

For eight or nine years the street railway fight in Cleveland dominated local politics. Mayor Tom L. Johnson fought and won many election campaigns with municipal street railway ownership or control and 3-ct. fares as the main issue. After Mayor Johnson had organized several companies to serve as a basis for his full scheme of municipal ownership these companies, with his approval were consolidated, with the Cleveland Electric Railway Co., which Mayor Johnson has been fighting, and the consolidated properties were leased to the Municipal Traction Co., (see News

Note, p. 515, May 17, 1908), on a total valuation basis of $23,690,000, and with provision for a virtual 3-ct. fare. Not long after, the Municipal Traction Co. went into the hands of a receiver, where it remained until March 1, 1910.

Through the agency of Mr. Robert W. Tayler, a federal court judge, a scheme for a compromise settlement of various points at issue between the city and the companies was elaborated in 1909. Mayor Johnson opposed this settlement plan, and submitted to the voters (Aug. 3, 1909,) a franchise for still another street railway company. This was voted down by a majority of 3,761 out of a total vote of 66,044, or only about two-thirds of the registration (see editorial note, Eng. News, Aug. 19, 1909). In November following Mr. Johnson was defeated for re-election.

On Oct. 5, 1909, Judge Tayler was invited by the city council and by the Cleveland Railway Co. to act as arbitrator of various points at issue. The various other street railway companies also invoked the aid of Judge Tayler. On Dec. 17, 1909, Judge Tayler submitted his report, which consisted chiefly of valuations of the properties and claims of the various companies. The object of the valuation was the fixing of capital value as a basis for fares and municipal purchase price in the settlement ordinance which has now gone into effect. In addition, Judge Tayler named the initial and the maximum rates of fare to be inserted in the franchise, which were those given below in our abstract.

The valuation thus fixed included $17,511,306 for the physical property and $3,615,844 for the franchises of the company, both as of Jan. 1 1908; nothing for good will, because covered in the franchise value, and nothing for going value, because not existing outside of physical value; and various allowances for stock transactions or dividend guarantees, etc., between the different companies.

We have spoken thus far only of happenings while and just after Mr. Johnson was mayor of Cleveland. He came into office after there had been a long and bitter fight over various street railway proposals. A part of this struggle, together with other related matters, was outlined in an essay entitled "The Street Railway Problem in Cleveland," by Mr. Rowland Hopkins, published in December, 1896, as one of the series of "Economic Studies" of the American Economic Association (see Eng. News, July 22, 1897, p. 63, for review of the essay). A review and criticism of the course of events under Mayor Johnson, written by Mr. W. S. Hayden, may be found in the Proceedings of the National Municipal League (Philadelphia) for 1909 (see brief abstract on p. 593 of Eng. News, of Nov. 25, 1909).

The Settlement Franchise.

We may now proceed with our abstract of the settlement franchise, which is substantially for 25 years, but will actually terminate on May 1, 1934. It provides for first-class construction, equipment and operation, subject to regulations provided in existing and future city ordinances. The city reserves the right to grant the use of the tracks and electric current of the company in specified portions of the city to other companies, on proper payment therefor. The company agrees to maintain and repair the pavements between and slightly outside its tracks, but this is not to be construed to mean repavement. The company puts itself under obligations to conform to time schedules and car routes fixed by the city, provided compliance with such orders will yield a revenue sufficient to enable the company to maintain the "interest fund" described below, or the company is permitted to make up deficits in the fund caused by compliance with such orders. [This power over running schedules is qualified later in the ordinance, as set forth below.]

A City Street Railroad Commissioner may be appointed by the Mayor, subject to approval by the city council, and to removal and reappointment of a successor in the same manner. The Commissioner is to

> act as the technical adviser of the council of the City of Cleveland in all matters affecting the interpretation, meaning or application of any of the provisions of this ordinance, and of action thereunder affecting the quantity or quality of service, or the cost thereof, or the rate of fare. He shall keep always informed as to all matters affecting the cost or quality or quantity of service furnished, the receipts and disbursements and property of the company, the rate of fare, the vouchering of expenditures; and if he disapproves of the vouchering of expenditures or of the manner of keeping accounts, or other matters affecting the bookkeeping of the company he shall at once take the matter up with the company, and in case of disagreement the matter shall at once be submitted to the committee on standard classification of accounts of the American Street and Interurban Railway Accountants Association, or to such person or persons upon whom the regulation of such matters may from time to time be devolved by law, and the decision of such committee or person or persons, not inconsistent with the provisions of this ordinance to whom this question is thus submitted, shall be final.

The company is to provide office accommodations for the Commissioner in connection with the general offices of the company, and must provide furniture, stationery and supplies. The Commission is to receive such salary, not in excess of $1,000 a month, as the Council may fix, and is authorized to appoint

> such assistants, accountants, engineers, clerks and other employes as he shall deem necessary to enable him at all times to inspect and audit all receipts, disbursements, vouchers, prices, pay-rolls, time-cards, papers, books, documents and property of the company.

The Commissioner is to fix the salaries of all such employees, subject to approval by the council, but the total of these salaries shall not exceed 1% of the allowances for operating expenses of any given month, as provided for in the franchise. The salaries of the Commissioner and his staff are to be met by the company and charged to operating expenses.

[Late in February, 1910, Mr. Geo. M. Dahl, whom we understand to be a lawyer was appointed Commissioner.]

Provision for arbitrating any differences between the city and the company which may arise is made in the franchise. Arbitration expenses, including fees of the arbitrators, are to be fixed by the arbitrators, and are to be paid by the company out of operating expenses, except that any such expense in excess of $5,000 within a period of six months is to be met from the interest fund.

As a penalty for violating any decision of the arbitrators the "interest payments" on the "capital value" of the company, other than bonds and floating debts, shall be reduced in such amount as the arbitrators determine, "but not lower than 1% below the rate then in force." Such reductions shall remain in force until the arbitrators are satisfied that their orders have been obeyed.

The following provision as to accounts and statistical records is notable:

> Sec. 15. At all times during the continuance of the rights herein granted, and any renewal hereof, the company shall keep in its office, open to inspection at all reasonable times, full, true and accurate accounts of all moneys expended and liabilities incurred in connection with said business and the maintenance and operation of said property, and also complete statistical accounts of its business and operations, which accounts shall be kept in the manner prescribed by the American Street and Interurban Railway Accountants' Association, or as may be provided by law or by any authority created by law, and the said company shall make and furnish to the City Street Railroad Commissioner monthly reports of its car mileage and earnings, and such other statements and reports, as the said commissioner may from time to time direct, and said commissioner shall at all times have access to and full authority to inspect, examine, audit and verify all accounts, vouchers, documents, books and property of the company relating to the receipt and expenditure of money and the business done by the company in the operation of its railway.

A unique feature of the franchise is the section which prescribes the basis for determining the capital value of the company for both rate or fare-fixing purposes and for determining the price to be paid for the property in case of municipal purchase. This capital value falls into three classes: (1) bonded indebtedness of the Cleveland Railway Co., which is the franchise grantee or contracting company; (2) floating indebtedness and miscellaneous claims of the four companies which sprang into existence during ex-Mayor Tom Johnson's railway campaign, together with $500,000 for the "interest fund" described further on, or so much of that sum as cannot be provided from cash in hand; (3) residual capital value. The following definition of residual capital value appears to give all the items which entered into net total capital value, except a comparatively small sum [perhaps $500,000] which was to be determined later on:

> Sec. 16. (c) The residue of the capital value of the company to wit the sum of $14,675,600. (The value of the property is agreed to be $21,127,149.53 to which must be added, as the value of The Forest City property $1,805,600, and there is added the sum of $1,158,300, interest accrued, but used to equalize stock value and not to be paid, said interest being the equivalent of 9% upon $12,870,000 for the period ending Jan. 1, 1910. The total of these sums is $24,091,049.53. From this aggregate is deducted bonded indebtedness of $8,128,000, and floating indebtedness as of Jan. 1, 1908, $1,288,000. The total of these sums is $9,416,000, leaving $14,675,049.53; agreed addition to equalize stock value, $550.47, making for residue of capital value, $14,675,600, with such additions thereto as may from time to time be made pursuant to the provisions of this ordinance.)

The interest fund of $500,000 appears to be designed to serve both as a reserve fund and as an index of the need of raising or lowering fares from time to time.

From the interest fund there is to be paid "all taxes and other payments herein provided to be made therefrom," together with 5% on the total bonded indebtedness of the company or not exceeding 6% on refunding bonds; plus 6% on the floating and allied indebtedness; plus 6% on the "residue of capital value and [subsequent] additions thereto." The company is given the privilege of extinguishing its existing floating debt by bond or stock issues. New bonds or stock or additional floating indebtedness, issued or incurred for permanent improvements with the consent of the city becomes a part of the capital value and the interest thereon becomes a charge on the interest fund. Capital obligations may be incurred without the consent of the city, but such shall not be added to the capital value.

The interest fund of $500,000 is to be augmented by the net earnings of the company, which are described as "all earnings" in excess of operating expenses and maintenance, depreciation and interest allowance. Any surplus of the interest fund, in excess of $500,000, after paying the items just named and taxes and the capital charges previously described,

> shall constitute a fund to be absorbed in the reduction of fares, and any deficiency in the interest fund below $500,000, in any period of operation, shall be first made good as is hereinafter provided, it being the intent hereof that the said interest fund shall be maintained at $500,000. . . .

The interest fund is to be deposited in banks, separately from the other current receipts of the company, and is to be credited with any interest which may accrue.

Detailed provisions for setting aside a percentage of gross receipts based on car mileages, to be used for maintenance and renewals, is made in the ordinance.

The franchise specifies that its intent as to maintenance and renewal charges is to keep the physical property up to a standard of 70% of its reproduction value.

The rates of fare which the company may charge are dependent on fluctuations in the "interest fund" above or below $500,000. The rates may range as follows, those under (a) being the maximum:

> (a) 4 cts. cash fare, 7 tickets for 25 cts., 1 ct transfer, no rebate.
> (b) Do., with 1 ct. rebate [on use of transfer].
> (c) 4 cts. cash fare, three tickets for 10 cts., 1 ct. transfer rebate.
> (d) Do., with 1 ct. rebate [on use of transfer].
> (e) 3 cts. cash fare, 1 ct. transfer, no rebate.
> (f) Do., with 1 ct. rebate [on use of transfer].
> (g) 3 cts. cash fare, two tickets for 5 cts., 1 ct. transfer, no rebate.
> (h) Do., with 1 ct. rebate [on use of transfer].
> (i) 2 cts. cash fare, 1 ct. transfer, no rebate.
> (j) Do., with 1 ct. rebate [on use of transfer].

Reasonable safeguards against the abuse of transfer privileges by such practices as a virtual round trip are inserted in the franchise ordinance. Children under six years of age, accompanied by an adult, are to be carried free, or two such children so accompanied for a single fare.

Immediately on the taking effect of the ordinance plan (a) is [was] to come into operation and continue for eight months; that is, 3 cts. cash fare and 1 ct. for a transfer. [This plan went into effect on Feb. 19; but to ride for 3 cts. a passenger was required to tender the exact change, or else to buy from the conductors 5 metal disks for 15 cts. Popular objection was made to this limitation on the 3-ct. fare, and it was reported that the limitation might be removed soon.]

If after eight months experience with the 3-ct. fare and 1-ct. transfer plan the interest fund already described has fallen below $500,000 then the company "shall install the next higher rate of fare" stipulated in the ordinance, or a still

higher one, at its discretion, if it thinks it required to restore and maintain the interest fund, provided that the maximum rate be not exceeded and the consent of the council (for any but the next higher rate) be obtained. In case of non-consent by the city the matter shall go to arbitration and whatever rate may be decided on by the arbitrators shall be collected for a period of six months. After the expiration of this six months an excess or a deficit of $200,000 in the $500,000 interest fund shall be "prima facie evidence of the necessity of" lowering or raising the rate of fare.

[It should be noted here that these provisions for maximum fare terminate, at the option of the company, any time within the last 15 years of the 25-year franchise, unless the city extends the franchise before its expiration. See statements near close of article.]

Further possibility of fare readjustments is provided by a clause which gives either the city or the company the privilege of notifying the other party that in the opinion of the first party the fares ought to be increased or decreased. If the second party does not agree to the change then the arbitrators provided for in the ordinance decide the question at issue.

As a safeguard against exorbitant salaries the ordinance provides that no employee of the company receiving more than $1,500 a year shall be paid a salary in excess of that "paid for similar work by other properties of same size."

Whenever the company proposes to make extensions, betterments or permanent improvements the City Street Railroad Commissioner shall have the right to employ assistants to check the company's estimates for the work, and if the work is carried out he shall have the right to employ assistants to check the material labor and other costs thereof. All bills for such work done for the Commissioner, after approval by the city council, and provided they do not aggregate more than 1% of the cost of improvements, shall be paid by the company. If the improvements are carried out these bills are to be included in the cost of the improvements; otherwise, they shall be classed as an expense to be met out of the interest fund.

On giving six months notice the city may buy the entire property of the company at its capital valuation, as fixed in the ordinance, plus 10%. In that event, the city will assume all bonded and other debts of the company, but the total of such debts shall be deducted from the capital value before adding 10% thereto. Furthermore, if the indebtedness of the company at the time of purchase, except as incurred for extensions, betterments and permanent improvements, exceeds 10% of the gross receipts of the company for the year preceding the purchase, then all that excess shall be deducted from the capital value before determining the purchase price.

After Jan. 1, 1918, the city may transfer its purchase option to any company of its chosing which has legal authority to acquire, own and operate street railways in Cleveland.

If at the expiration of the franchise the city has neither exercised or transferred its purchase option then the city may buy out the company on terms mutually agreed upon or else fixed by arbitration. Under such conditions the price to be paid for the property "shall be its value for street railroad purposes," and shall be the cost of reproduction of all the physical property of the company within the city limits, minus "a reasonable amount for depreciation," plus 10% of the remainder, but no allowance shall be made for franchise values or for any money in the interest fund. The city shall not be bound to take the property after a price has been put upon it by arbitrators under this part of the franchise.

In case none of these possibilities for purchase by the city or for transfer of the purchase option are availed of by the city on the expiration of the franchise then the right of purchase of the whole or a part of the property shall be vested in any person or persons to whom the city may grant a franchise for operating street railways in Cleveland, the price in that event to be the reproduction cost, fixed as outlined.

The maximum rate of fare named in the ordinance may be charged by the company, and the city will then lose control of the car schedules (except as to police powers), at any time during the last 15 years of the life of the 25-year franchise, unless the city extends the franchise beyond its original term, in accordance with provisions which will not be cited here. In case the company thus establishes the maximum fare then whenever the $500,000 interest fund is swelled by $200,000 or more all the excess is to be applied to the reduction of the capital value of the property, first by paying floating debts, then by paying off bonds, if possible, and if not possible then by paying the excess into a sinking fund. The reductions in capital value thus effected would inure to the advantage of the city or any city licensee in case of purchase of the property of the company.

Distribution of Sea Water in the Charles River Basin After Excluding Tidal Waters.

By MORTON F. SANBORN.*

The Charles River Basin is an artificial basin recently formed by the construction of a dam between Boston and Cambridge at the site of the old Craigie Bridge.

The present investigation was undertaken to determine the rate of freshening of the water in the basin and the percentage of sea water at different depths after the tidal flow was excluded. While carrying on this investigation, studies were made upon the vertical circulation caused by the wind and waves, and upon the interchange of fresh and salt water brought about by the operation of the large boat lock.

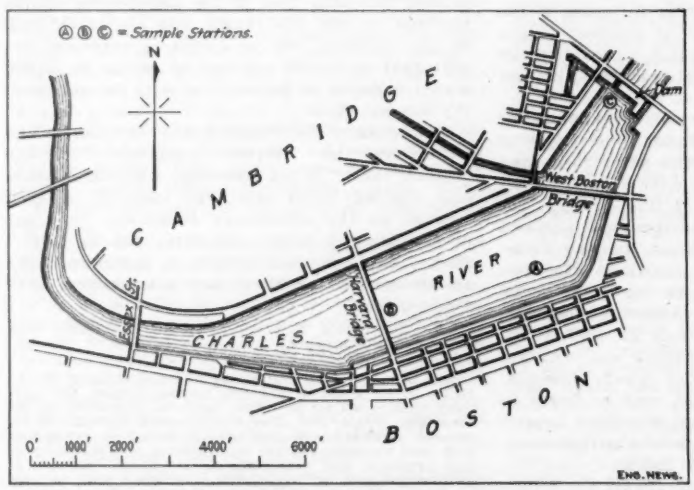

FIG. 1. PLAN OF CHARLES RIVER BASIN, BOSTON-CAMBRIDGE, MASS., SHOWING SAMPLING STATIONS.

While these are three distinct and important subjects, it was thought advisable to discuss them all in this paper as each is dependent somewhat upon the others.

The Charles River Basin extends to the dam at Watertown, and is about 8½ miles long, from 150 to 2,300 ft. wide, the deepest part being about 30 ft. The upper part, about six miles long, is from 150 to 400 ft. wide and very winding, with a depth varying from 15 ft. at the lower end to 3 ft. at the upper end. The lower basin is about 2½ miles long, extending from the dam to Essex St. Bridge, the widest part being about 2,300 ft.

The dam is an earth embankment with masonry retaining walls on the down-stream and up-stream faces, and is 1,200 ft. long and from 100 to 500 ft. wide.

There is a large boat lock on the Boston side of the river, and on the Cambridge side a small boat lock with four sluices on each side.

The bottoms of the sluices are 10½ ft. below the surface. One of the sluices is connected with a salt-water sluice having a 5 × 5-ft. intake, with the invert 26½ ft. below the surface.

There are also gates 18 ft. below the surface in the large lock gates, through which the water is sometimes allowed to flow.

The water in the basin is maintained near Grade 8, Boston City Base. The average rise and fall of tide in the harbor is about 10 ft., low water being about Grade 0.

The river has a drainage area of 308 sq. mi. The run-off of 70 sq. mi. is considered as being diverted from the river at Dedham and flowing into Mother Brook, a tributary of the Neponset River, and that of 24 sq. mi. is used for the water-supply of the city of Cambridge. Several cities and towns also take their water-supply from wells on its banks.

The average flow into the basin varies from 30 cu. ft. per sec. during part of the summer to 500 cu. ft. per sec. in the spring.

The amount of chlorine found at any point was taken as an index of the amount of salt water present. The normal chlorine of the North Atlantic Ocean is 20,840 parts per million, and the writer has found in the inner harbor 20,250 parts per million. The normal chlorine as found in the river at Watertown will vary from about 6 parts during the high flow to 12 parts per million during the low flows.

The percentage of sea water present is found by the formula:

$$x = \frac{100\ (Cl - n)}{20840 - n}$$

In which x = percentage of sea water; n = normal chlorine of river water = 9 parts per million average. Cl = chlorine.

The samples of water for testing were taken in a ½-pint bottle, 7 ins. high, with a neck 1½ ins. long. The bottle was strapped to a piece of wood 1½ ft. long, with a weight tied to the lower end and a rope tied to the upper end, and with knots tied in the rope so as to show the depth of the top of the bottle below the surface. The bottle was thus always held in an upright position. A smaller line was made fast to the stopper and when the bottle was at the right depth the stopper was removed from the bottle and the bottle held in that position until the air bubbles had ceased to rise to the surface, thus showing that the bottle was full of water.

The lower water, being as heavy or heavier than the upper water, would stay in the bottle and not flow out as the bottle was raised to the surface; but as an extra precaution the water in the neck and upper part of the bottle was removed as soon as possible.

The map (Fig. 1) shows the general plan of the lower basin and the location of the sampling stations. The samples were taken 1, 5, 10, 15, 20 and 25 ft. below the surface. The results of these tests are plotted on Fig. 2.

The samples were taken at Sample Station A from Nov. 4, 1908, to Dec. 14, 1908. As the river was frozen part of the winter the samples had to be taken at Harvard Bridge Draw Pier, sample station B, from Dec. 14, 1908, to Jan. 25, 1909, and after Jan. 25, 1909, they were taken above the dam at sample station C.

In taking samples at station C care was always taken to see that all gates and sluices were shut so that there would not be any currents in the water to affect the samples.

The usual custom of having zero at the bottom is reversed in this diagram so that the line indicating the lighter fresh water is at the top, while the heavier salt water is at the bottom. When two or more lines coincide, the line representing the greater depth is drawn.

The shut-off gates were dropped Oct. 20, 1908, closing the river to the tide. The basin then con-

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ained salt water freshened somewhat by the low down the river. On Nov. 4, 1908, the water n the basin had from 13,000 parts per million f chlorine on the surface to 18,000 parts at the -ft. depth. The water slowly became fresher,

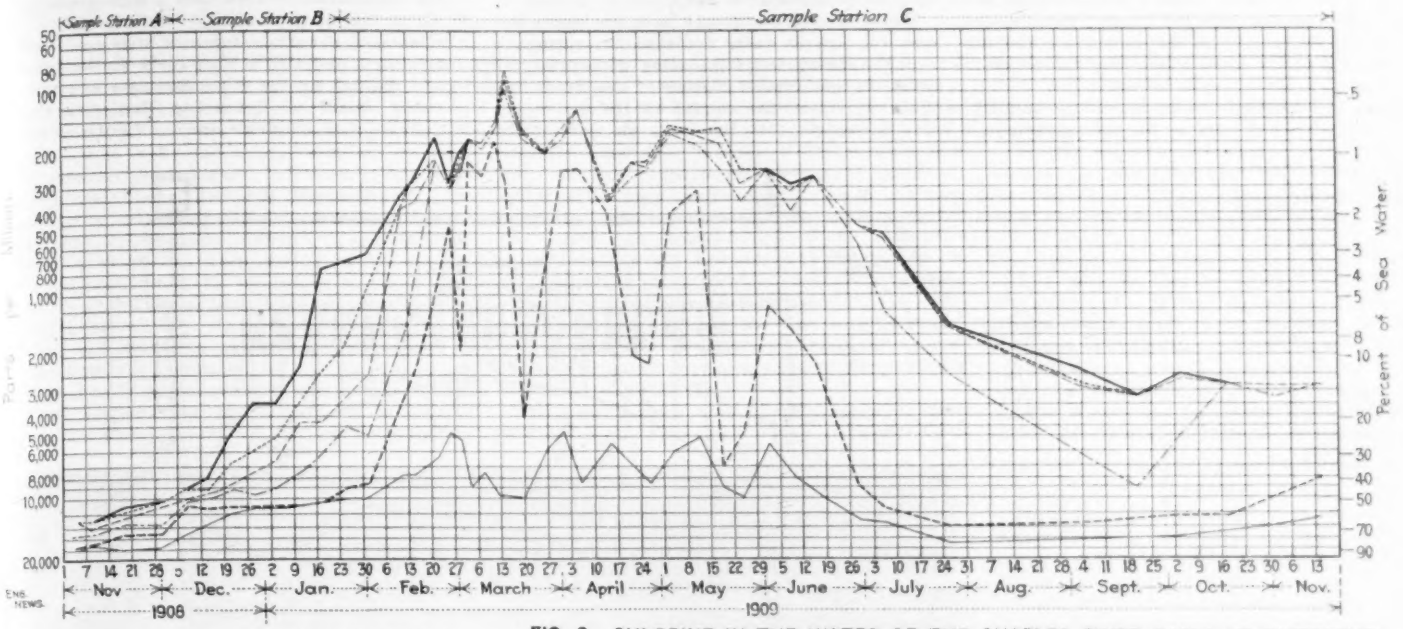


FIG. 2. CHLORINE IN THE WATER OF THE CHARLES RIVER BASIN AT DIFFERENT DEPTHS AND DATES IN 1908-9.

as there was not much flow until about Dec. 12, 1908.

From Dec. 14 until Feb. 22, the water became fresher at a more rapid rate with the increased flow. From Dec. 14 to 22, ice had formed on the river so that the fresh water floated on top with nothing to mix it up with the heavier water below. Then some warm weather and wind caused the surface to hold at about the same and the lower depth became fresher. Jan. 9 to 18, the river was again frozen over and the surface water again jumped to a fresher state. After Jan. 23, the ice gradually disappeared and the lower depth became fresher while the surface chlorine did not decrease very fast.

From Feb. 11, to June 17, 1909, the chlorine in the water for the first 15 ft. kept very uniform, becoming less on very high flows or in calm weather, and greater after a wind storm. The 20-ft. depth kept varying from the heavier water at the bottom to the lighter water above 15 ft, increasing during calm weather and heavy lockage and decreasing during storms.

The 25-ft. depth was high in chlorine all the year, the least being on April 1, 1909, when it contained 4,750 parts per million. From June 17, to Sept. 21, the chlorine in the water steadily increased, due to the large number of boats passing through the lock and to the small flow of water down the river. After Sept. 21, the water slowly became fresher, due to the larger flow.

The surface water was used to make steam on some of the lighters and dredges, during the spring, but not with satisfactory results, as it would foam in a few days and then the water would have to be blown out of the boilers every day or two, leaving enough water to make steam to pump a new supply into the boilers.

Vertical Circulation Caused by the Wind and Waves.

While studying the freshening of the water, it was noticed after a wind storm that the salt content of the surface had increased while that of the lower depth had decreased, so a special set of tests was made during the spring to determine what circulating effect was caused by the waves. The lower basin is divided into three parts by Harvard Bridge and West Boston Bridge, causing somewhat of a break in the force of the wind and waves. The results of these tests have been plotted and a curve drawn (Fig. 3) showing the approximate greatest depth at which the wind causes a complete mixing with the surface water. The curve is plotted through or near the lowest velocity, as it is assumed that the same results were obtained before reaching the higher velocities. The curve from the 20 to the 25-ft. depth is extrapolated. The salt at the 25-ft depth was never found reduced to that of the lesser depths. This is due to the addition of salt water from the lock, to the difficulty with which the heavier salt water mixes with the lighter fresh water, and to the unevenness of the bottom at that depth.

The wind velocities given were obtained from the U. S. Weather Bureau at Boston and are the average velocities during storms. The prevailing wind has been from the west or down the river, and only those winds that have blown down or up the river have been considered in these experiments.

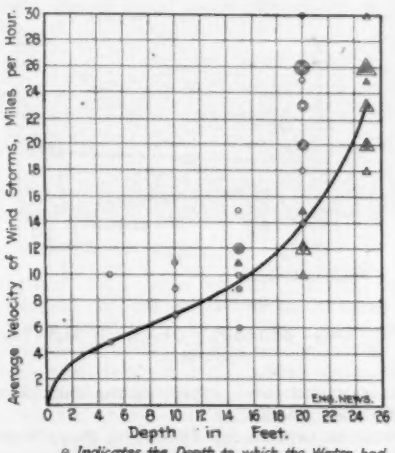

Average Velocity of Wind Storms, Miles per Hour.
Depth in Feet.
ENG. NEWS.
○ Indicates the Depth to which the Water had a Uniform or nearly so Strength of Chlorine after a Wind Storm.
△ Indicates the Depth to which the Chlorine was reduced by the Waves.

Fig. 3. Curve Showing Approximate Greatest Depth at which Wind Causes a Complete Mixing of the Surface Water in the Charles River Basin.

When the samples of water from different depths showed different densities the tests appeared to indicate that during a wind storm the mixing of the water started at the surface and worked downward. This is shown by the following tests taken on March 15, 16 and 17, 1909, as is also the completeness of the mixing caused by the waves.

At the manhole which is at the head of the salt-water sluice as it comes up into the Basin Wall, the water was noticed to rise and fall during the storm ⅛ to ¼-in. This motion must have come through the intake, which is from 21½ to 26½ ft. below the surface.

The same results could not have taken place during the summer and fall, as it requires long and continued wave motion to mix the lighter water with the heavier sea water.

In a fresh water lake or reservoir with a like fetch but deeper, where there is not the heavier water to mix with, it is probable that the effect of the waves would be felt much deeper.

The Interchange of Fresh and Salt Water Brought About by the Operation of the Lock.

The large boat lock is 350 ft. long, 45 ft. wide, and 21 ft. deep below the surface of the water in the basin.

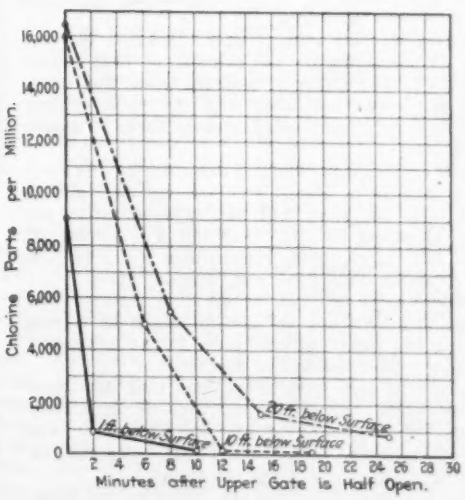

Chlorine Parts per Million.
Minutes after Upper Gate is Half Open.
1 ft. below Surface
10 ft. below Surface
20 ft. below Surface

Fig. 4. Illustrating Change of Water in Lock of Charles River Dam when Changing the Opening from the Harbor to the Basin or River.

(The first samples were taken after the lock had been open to the harbor about 45 minutes. Fresh-water was started when upper gate was one-third open and it took 2 min. 50 sec. to reach the lower gate.)

Depth, ft.	Parts per Million Chlorine. March 15, 9 a. m.	March 16, 5 p. m.	March 17, 5 p. m.
1	80	130	140
5	80	130	140
10	85	130	140
15	95	130	140
20	280	130	140
25	10,000	10,000	7,500

March 15, 9 a. M. to 6 p. m. average wind, 16 miles.
March 16, 12 noon to 5 p. m. average wind, 13 miles.
March 17, 12 noon to 5 p. m. average wind, 23 miles.

Fig. 4 gives the result of a test showing the complete change from salt water to fresh water, the salt water going into the basin at the bottom and the fresh water coming in over the salt water and displacing it.

The same action is noted when changing the lock from the basin to the harbor, namely, the coming in underneath of the salt water and the flowing out of the fresh water over the water in the harbor.

The lock contains from grade —13 to half tide 283,500 cu. ft. and this is the average amount of salt water that flows into the basin at every lockage. It equals 3.28 cu. ft. per sec. for 24 hours.

Opening from the basin to the harbor 330,750 cu. ft. of fresh water flow out into the harbor. This is equal to 3.83 cu. ft. per sec. for 24 hours.

The net loss of water from the basin at every double lockage is therefore equal to .55 cu. ft. per sec. for 24 hours.

The small boat lock is 63 ft. long, 10 ft. wide and 11½ ft. deep when open to the basin. The average amount of sea water let in at each lockage is 4,725 cu. ft., which is equal to .05 cu. ft. per sec. for 24 hours.

There was an average of 30 lockages per day for 14 weeks during the summer of 1909 caused by the large number of pleasure boats, and lighters and scows connected with the work. Thirty lockages with boats will represent about 20 double lockages.

The evaporation from the basin during the summer months is about 6 cu. ft. per sec. and is computed by using 5.67 ins. of evaporation per day as found by Mr. Desmond FitzGerald, M. Am. Soc. C. E., from experiments made by him at Chestnut Hill Reservoir, Boston, Mass.

When all construction work is finished the large lock will not be used so much as it was during the tests and the water in the basin will probably be considerably fresher.

It will be seen from these tests that the water in the basin will not at any time be completely fresh. The amount of sea water present will depend upon the usage of the boat locks and the flow of fresh water down the river.

The distribution of the sea water in the basin will depend upon the circulation caused by the wind and waves.

Summary of Conclusions.

These studies may be useful in drawing conclusions as to how any basin under similar conditions would act.

Fig. 2 shows conditions that are probably similar to any river under the conditions at the Charles River Basin, when the salt water lies at the bottom. The surface water could not be depended upon for water-supply at all times, as during a wind storm the surface water would take up salt water from the bottom.

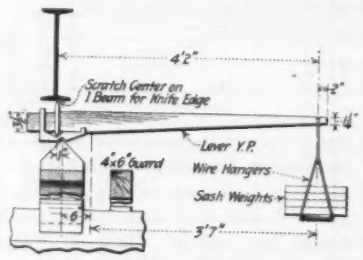
The water in the basin will not be suitable for boiler use. The water in the basin would make an ideal supply for fire purposes if it could be depended upon to be fresh. The variation from nearly fresh water at the surface to salt water at the bottom and from fresher water in the spring to salter water in the summer would not be good conditions for fish.

When the river is frozen over the curve shows how the lighter water floats on the surface.

In the spring and fall, during the storms, there must be considerable mixing of the water in the lakes and reservoirs caused by the waves.

It is thought that the study on vertical circulation might add a little to the knowledge of wave action.

In the study of the action of the water caused by the operation of the boat lock, it has been shown that there is a surface flow towards the salt water after either gate is opened. This flow amounted to 2.1 lin. ft. per sec. on the test of March 9, 1909. The boats in passing through the lock from the harbor to the basin have to go against the current, and in passing through in the reverse direction go with the current. This is a condition that would occur in any lock between salt and fresh water; as the end locks of the Panama Canal.



Section A-B

Fig. 2. Detail of Loading Device on Arch-Testing Apparatus.

I wish to express my thanks to Prof. William T. Sedgwick, Director of the Sanitary Research Laboratory of the Massachusetts Institute of Technology, for the use of that Laboratory.

GASOLINE TAXICABS in New York City now number about 2,500 and have generally displaced both the horse-drawn cabs and the electric storage-battery cabs, which were the first taxicabs introduced.

A NATIONAL CONVENTION OF INVENTORS is to be held at Rochester, N. Y., June 13 to 18, 1910, under the auspices of the International Congress of Inventors, an organization established four years ago to work for the reform of patent law and procedure and the better protection of inventors' rights. The President of the organization is Mr. Geo. F. Gallagher and the Treasurer is Mr. Geo. B. Selden, whose name has received wide publicity for his foundation patent on automobile construction. Arrangements for the convention in June are in the hands of Mr. Alexander B. Lamberton, President of the Board of Park Commissioners of Rochester.

Tests of Model Concrete Arches by the New York State Engineer's Office.*

At Medina, N. Y., there is a deep gorge on the line of the New York State Barge Canal where the topography is such that a high-grade crossing is absolutely necessary. After a careful consideration of various types of steel and concrete aqueducts and also a high earth embankment, it was decided by the State Engineer and the Advisory Board of Consulting Engineers that a concrete arch of single span, with the necessary approaches, is to be preferred to other possible types of construction.

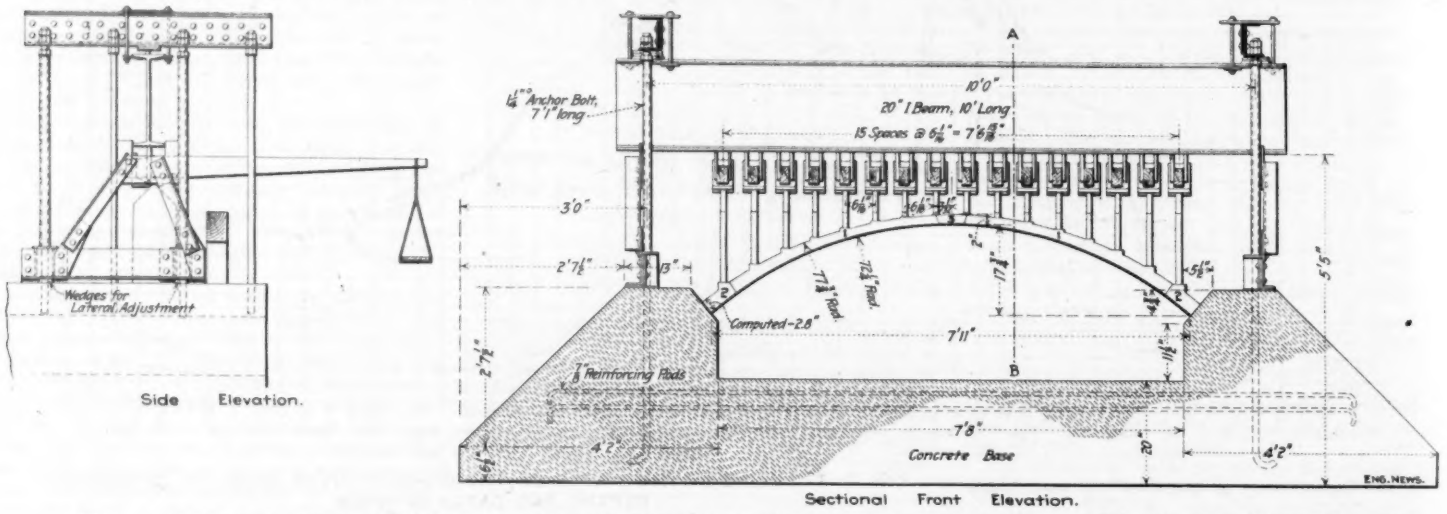


FIG. 1. DETAILS OF MODEL CONCRETE ARCHES AND APPARATUS FOR TESTING THEM USED BY THE STATE ENGINEER'S OFFICE OF NEW YORK.

The load to be carried consists of a prism of water, having a maximum depth of 13 ft. 2 ins., and weighing 825 lbs. per sq. ft., in addition to the weight of the trough, piers and arch ring. The total weight of water to be carried by the single span is 12,400 tons, while the total load, including the weight of the structure, is 46,000 tons. The water load may at times be removed, and is to this extent a live load, although it is always uniform for the full length of the structure and is never accompanied by impact.

The span, center to center, is 290 ft. 6 ins. The clear span opening of 285 ft. cannot properly be reduced. The rise is 53 ft. 5 ins. The total width of the structure is 129 ft.

Other notably long-span concrete arches are the Walnut Lane bridge, Fairmount Park, Philadelphia, and the arch over Rocky River, at Cleveland. The Walnut Lane bridge was completed in 1909. It has a clear span of 233 ft. and a total width of 60 ft. The live load is 100 lbs. per sq. ft. The total live load carried by the structure is 700 tons, and the total load, including the weight of the structure, is 12,000 tons. The Rocky River bridge is now being built. It has a clear span of 280 ft. and a total width of 60 ft. It carries a live load of 150 lbs. per sq. ft., a total live load of 1,200 tons and a total load, including the weight of the structure, itself amounting to 16,000 tons.

Thus it will be seen that by virtue of the length of span, the total width, the great load to be carried and the necessarily great cost, the Medina aqueduct may properly be considered a most important piece of concrete arch construction. It was therefore deemed both advisable and necessary not only to develop the design with the greatest care along the lines of the most approved theory of arch construction, but to make a series of tests on concrete prisms and model arches, for the purpose of obtaining additional information concerning the behavior of concrete under certain conditions of stress.

At the meeting of the American Society of Civil Engineers, held Sept. 15, 1909, a paper was presented, entitled "Walnut Lane Bridge," Phila-

*This description with the cuts is a portion of a report to Mr. Frank M. Williams, State Engineer and Surveyor of New York, and has appeared in the "Barge Canal Bulletin" for February.

delphia."* This paper contained the following statement:

> Tests of concrete model arches, made in order to determine questions of design, indicated that it is wise to treat the components of the direct arch stress at the abutment as so much shear acting in a beam. Regarded as such, the vertical component or reaction at the spring of the main arch ribs of this bridge amounts to 108 lbs. per sq. in. of arch section in shear at the face of the skew-back, which would be high for simple concrete, but is allowable for the hybrid† materials.

There was no discussion by any member of the Society challenging this opinion.

To construct at Medina an arch of sufficient thickness to carry the heavy loads and to keep the shear at the low value indicated by the foregoing quotation is decidedly impracticable. Inasmuch as failure by "shear"—or more properly speaking, by "diagonal tension"—in a reinforced-concrete beam has been clearly shown by repeated experiments to commence in the tensile portion of the beam, even where the cracks, once started, extend into the compression side of the beam, and inasmuch as the arch rib should be approximately compared in the nature of its stresses with the compression side of a beam and not at all with the tension side, it is believed that the statement quoted is incorrect and that there is no danger of failure by so-called shear in a properly designed arch. The term shear, as here used, has nothing to do with the phenomena observed in connection with true compression failures under high intensity of stress, and relates only to the possibility of failure along some diagonal plane, before the true compressive resistance of the concrete is fully developed. The literature of concrete frequently refers to the failure of cubes and prisms by shear, when tested by compression to destruction. Just what is meant in such cases by the word shear is not always clear.

Since no satisfactory evidence could be found of adequate tests ever having been made to prove that the arch would not fail by shear near the spring under shearing stresses of comparatively small intensity, as intimated by the foregoing quotation, it was believed to be still more necessary to obtain further information by tests, both on prisms and on model arches, which should be exact counterparts, except as to size, of the ribs of the proposed arch at Medina.

For various reasons it was not believed that the compressive resistance obtained in the test would show the actual unit strength of the full-sized structure. However, it was believed that important information could be secured in regard to the kind of failure and the ultimate strength of arches, as compared with cubes made of the same material, at the same time and by the same experimenter.

It is well known that, on account of the variations of the modulus of elasticity of concrete under varying intensity of stress, the distribution of stress in the compression side of a reinforced-concrete beam does not follow the straight line law. It was believed that a similar condition exists under high compressive stress in the case of prisms, columns or arch ribs carrying eccentric loads. In order, therefore, to determine more definitely the allowable working stress in the arch under eccentric stress caused by extreme conditions of temperature and loading, as compared with the allowable average working stress, it was considered advisable to include in the test a series of concrete prisms some of which should be loaded eccentrically.

Six model arches, without reinforcement, have already been made and tested to destruction.

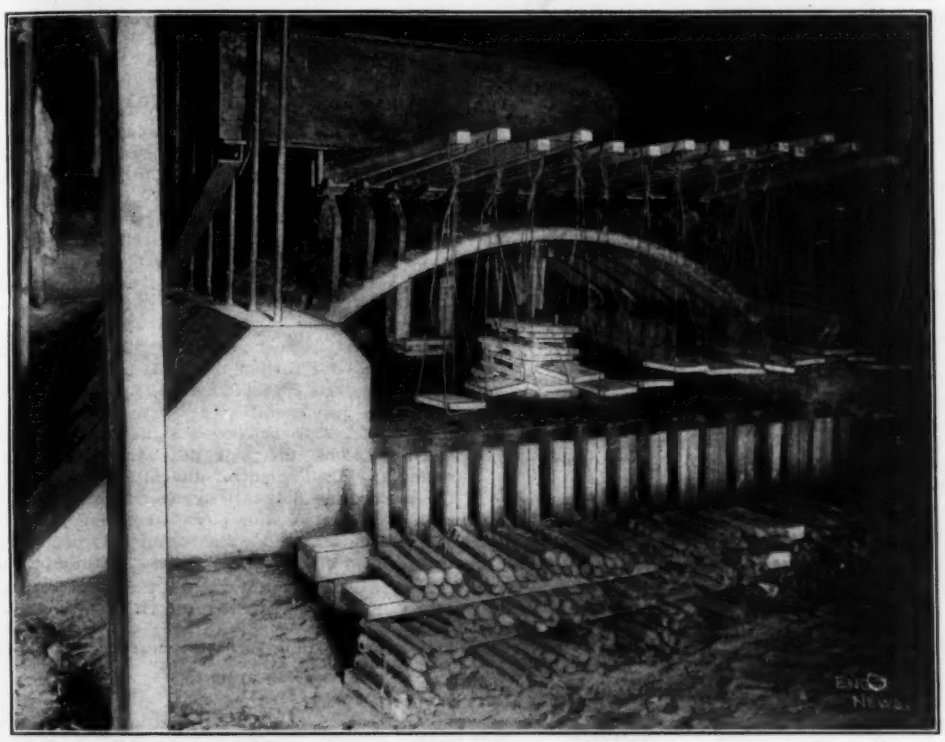


FIG. 3. VIEW OF MODEL ARCHES UNDER TEST.

Three of these were reduced in section near the springing for the purpose of encouraging failure at that point by vertical shear. These tests, on account of certain difficulties with the testing apparatus and other difficulties encountered in making the models, all of which have since been overcome, were not entirely satisfactory and should not be accepted as conclusive in all respects. They will be followed by another series to be made in the near future, the results of which will be published in a future report. The tests already made, however, do conclusively show that, whatever the ultimate cause of failure, it does not occur until the model has developed a high unit resistance in compression. It is therefore evident that, if reasonable values are chosen for the intensity of the allowable working compressive stress per square inch, no attention need be paid to the intensity of the shearing stresses at the springing. A complete description of the apparatus for testing the model arches and a discussion of the results will be found in this report under their respective headings.

When the concrete prisms were tested, a few specimens were provided with diagonal grooves, made for the purpose of encouraging failure by diagonal shear. While the tests are not to be conclusive in all points until corroborated by an additional series of tests, which also will be made in the near future, yet it is believed that two important conclusions can be drawn at this time, as follows:

(1) Whatever the kind of failure, it does not occur until the prism has developed a high compressive resistance. This conclusion, therefore, amply reinforces the conclusion hereinbefore drawn from the tests on arch models with respect to the danger of failure by shearing near the springing.

(2) The apparent intensity of compressive resistance by the extreme fiber under eccentric loading, when figured upon the assumption of a straight line distribution of stress, is much higher than the average resistance per square inch for prisms loaded centrally, being approximately 33% higher for prisms with 1 in. eccentricity and over 50% higher with 2 ins. eccentricity. This seems to demonstrate conclusively that the distribution follows substantially the same law as is known to exist for the compression side of reinforced-concrete beams. A discussion of the tests on prisms will be found later under its proper heading.

General Description of Model Arches and Apparatus.

Each dimension of each of the model arches was 1/36 of the corresponding dimension of the present Medina arch (Fig. 1). The large arch will carry a total average load of about 2,450 lbs. per sq. ft. This load is considerably greater toward the springing than at the crown, on account of the greater thickness of arch rib and the greater weight of the piers which carry the trough. Under this load an average stress of about 500 lbs. per sq. in. will be produced in the large arch. Approximately the same stress will exist in the models under the same load per square foot with the same distribution. The weight of the model rib itself is so small as to be almost negligible. If, then, the concrete in the model has an ultimate average strength of 2,500 lbs. per sq. in., an average load of approximately 12,250 lbs. per sq. ft. will be required for destruction. It is impossible to apply so great a direct load with any certainty that the loads are applied as intended. For this reason a system of 16 independent levers and knife edges (multiplying the loads by 50) was arranged, as shown in Fig. 1.

The knife edges (Fig. 2) were made of hardened steel. The special castings for the levers were designed so as to bring the two knife edge bearings and the applied load in the same plane. In this manner the ratio was kept constant and the loads applied to the arch were kept vertical, with errors so slight as not appreciably to affect the results.

The building in which the tests were made was an old shed which had no floor. It was full of cracks and was unheated. The temperatures during the making and testing ranged from about 0° to 40° F. However, the models were thoroughly protected and were not frozen.

The abutments were made of 1:3:6 concrete and were cast directly on the ground. They were made massive and were heavily reinforced so as practically to reproduce the unyielding abutments of the large arch. However, there was a slight yielding under the extreme loads required for the destruction of a model and small additional stresses similar to those produced by the rib shortening were thus introduced.

The general dimensions of the model arches and abutments are shown in Fig. 1. In the first series six arches were cast, made of mortar composed of one part Portland cement and two parts of Albany sand. In order partially to eliminate stresses due to shrinkage, three sections, or keys, were provided, one at the crown and one at each springing, which were filled two days after the body of the arch was cast. During the test it was found that some of the keys had not been quite thoroughly filled. This was particularly true of the keys at the springing. The imperfect contact at this point undoubtedly led to lower results than would otherwise have been secured.

Each arch was constructed in two layers, the

*Transactions, American Society of Civil Engineers, Dec., 1900, p. 423.

†Hybrid material, as here used, means concrete in which are embedded flat stones, packed close, with bed of stones at right angles to arch thrust.

TABLE I.—TESTS OF MODEL ARCHES.—DEPARTMENT OF THE STATE ENGINEER, STATE OF NEW YORK, SERIES NO. 1.
Arches 7′ 11″ clear span, 2″ thick at crown. All models composed of 1 part Portland cement and 2 parts Albany sand.

Arch No.	Age days.	Loads exerted on arch by weight of arch, plates, levers, &c.	Loads. P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	Total load on arch in lbs.	Load on arch per sq. ft., lbs.	Total Stresses At point P_1 Top.	At point P_1 Bottom.	At springing Top.	At springing Bottom.
1	33	Weight on levers at failure, Approximate)	256	240	225	217	211	207	204	203	...	...	238	34	159	85
		Total load on arch	150	150	145	140	150	135	150	145	...	...	...	...	...	...
2	36	Weight on levers at failure	97½	103	88½	82½	82½	73½	73½	64½	70,076	12,500	4,378	1,804	2,710	3,664
		Total load on arch	5,131	5,390	4,650	4,342	4,336	3,882	3,879	3,428	64,926	11,600	3,370	1,454	1,953	2,451
3	42	Weight on levers at failure	87	90	82	80	80	69	69	57	59,226	10,580	3,111	1,264	752	4,104
		Total load on arch	4,606	4,740	4,325	4,217	4,211	3,657	3,654	3,053	56,826	10,140	2,722	1,350	19*	4,595
4	39	Weight on levers at failure	79	85	75	70	70	63	63	52	53,726	9,600	2,839	1,139	729	3,687
		Total load on arch	4,206	4,490	3,975	3,717	3,711	3,357	3,354	2,803						
5	46	Weight on levers at failure	79	85	75	70	63	57	57	47						
		Total load on arch	4,206	4,490	3,975	3,717	3,361	3,057	3,054	2,553						
6	49	Weight on levers at failure	71	77	67	63	63	57	57	47						
		Total load on arch	3,806	4,090	3,575	3,367	3,361	3,057	3,054	2,553						

*Tension.

first layer of all the arches being deposited before the second layer of any was begun. The length of time required for this work was considerably greater than had been anticipated and some of the material had taken an initial set before the work was finished. While it is probable that this did not greatly weaken the material, yet the tests apparently showed the effect of the initial set at the time of failure by the splitting of the ribs in several cases along the line of separation between layers.

As might have been expected with a new piece of testing apparatus, certain modifications were found necessary in order to secure the best results. Such modifications as were necessary have been made and the difficulties met with during the first series have been so overcome that the projected series will doubtless be of more value than the first.

When the first arch was tested, the loads were applied by means of sand poured gradually according to a carefully prepared program into bags suspended from the ends of the levers. This plan was generally successful, but on account of difficulties in handling the sand and of the objectionable dust, cast-iron sash weights of various sizes were used for the other tests. These weights were carefully applied, also according to program, by hand, one at a time, so as to avoid shock and keep the line of pressure very nearly in the desired position. The desired ratio of loads was computed after several trials and was so chosen as to keep the line of pressure as close as possible to the axis of the arch at all points. The ratio was approximately maintained throughout the entire application of the loads, the per cent of variation from the ratio constantly decreasing during application.

However, additional bending stresses were momentarily produced and the ultimate breaking loads, therefore, were probably slightly less than would have been found, had a more ideal method of loading been followed. All of the arches had open joints closed under moderate loads.

Arches Nos. 4, 5 and 6 were reduced 38% in section near the springing, in order, if possible, to encourage failure by shear on a vertical plane. The loading for these was identical with that for the others and the eccentricity of the reduced section has been considered in computing the stress on the extreme fiber.

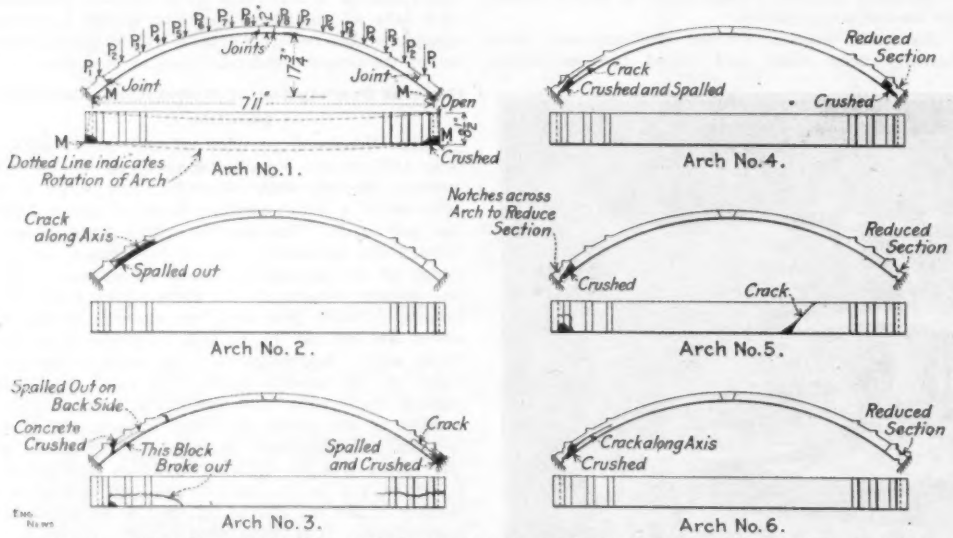


FIG. 4. DIAGRAMS SHOWING KINDS OF FAILURE ON SIX MODEL CONCRETE ARCHES TESTED BY THE NEW YORK STATE ENGINEER.

All stresses given in the table (Table I.) are computed for actual loads at time of failure. The formulas used may be found in Church's "Mechanics for Engineers," Johnson's "Framed Structures" and Turneaure and Maurer's "Principles of Reinforced-Concrete Construction." As is customary, the variation of modulus of elasticity of concrete under varying intensity of stress, has been ignored and a straight line distribution assumed. The effect of rib shortening has been included. The effects of shrinkage and temperature are comparatively small and have not been included. Allowance was not made for the reduction of restraint due to the reduction at the springing of models Nos. 4, 5 and 6. The tabular stresses are, therefore, believed to be somewhat too high.

Description of Arch Tests.

Arch No. 1 was heavily loaded three times. Sufficient allowance was not made for the deflection of the levers and the 20-in. I-beam was not properly braced horizontally. The multiplying ratio of the levers was therefore maintained only through a portion of the test. The vertical knife edges were thrown out sufficiently to produce a severe horizontal thrust on both I-beam and arch. The arch finally rotated about an axis (M-M, Fig. 4), crushing the concrete at these points to such an extent that the model was useless for further tests. It is impossible to determine even approximately the maximum unit resistance developed.

Arch No. 2 first showed signs of failure by splitting along the axis near the key at the springing. On account of difficulties of adjusting the apparatus, not entirely overcome when this arch was tested, the piers were not properly centered on the arch. The eccentricity of loading thus caused increased the stresses at the extreme

TABLE II.—TESTS OF PLAIN CONCRETE COLUMNS AND CUBES.—DEPARTMENT OF THE STATE ENGINEER, STATE OF NEW YORK, 1909.

Columns, 6″ × 6″ × 36″; Cubes, 6″ × 6″ × 6″. Composition: 1 part American Portland cement; 2 parts Albany bank sand; 4 parts ¾″ limestone. Tested at Rensselaer Polytechnic Institute, Troy, N. Y., Nov. 11-15-19, 1909. Temperature at Mixing 60°—65° F. Age of all specimens was 21 days.

Specimen Number 1st batch.	2d batch.	3d batch.	Size.	Description.	How loaded	Load at incipient failure.	Load at ultimate failure.	Stress per sq. in. at incipient failure.	Stress per sq. in. at ultimate failure.	Average Stress at ultimate failure.
1	..	..	6″ × 6″ × 6′	Plain sides	Centrally	82,300	82,300	2,280	2,280	....
..	13	..	"	"	"	73,500	100,200	2,040	2,780	2,520
..	..	25	"	"	"	90,230	90,230	2,500	2,500	....
2	..	..	6″ × 6″ × 36″	Square ends plain sides	"	39,500	39,500	1,100	1,100	....
..	14	..	"	"	"	76,170	76,170	2,110	2,110	2,075
..	..	26	"	"	"	73,570	73,570	2,040	2,040	(Aver. of 2)
3	..	..	"	"	Eccentrically 1″	51,190	51,190	2,840	2,840	....
..	15	..	"	"	"	49,280	49,280	2,740	2,740	2,780
..	..	27	"	"	"	49,640	49,640	2,760	2,760	....
4	..	..	"	"	Eccentrically 2″	25,600	29,970	2,840	3,330	....
..	16	..	"	"	"	25,810	25,810	2,870	2,870	3,107
..	..	28	"	"	"	28,040	28,040	3,120	3,120	....
5	..	..	"	Square ends, sides grooved 1″ deep, 39° with vertical	Centrally	52,270	52,270	1,784	1,784	....
..	17	..	"	"	"	74,800	74,800	2,532	2,532	2,259
..	..	29	"	"	"	72,910	72,910	2,461	2,461	....
6	..	..	"	"	Eccentrically 1″	50,100	50,100	3,150	3,150	....
..	18	..	"	"	"	44,600	44,600	2,480	2,480	2,913
..	..	30	"	"	"	49,450	49,450	3,110	1,110	....
7	..	..	"	"	Eccentrically 2″	24,100	24,100	3,160	3,160	....
..	19	..	"	"	"	18,000	21,950	2,000	2,439	2,706
..	..	31	"	"	"	19,200	19,200	2,520	2,520	....
8	..	..	"	Square ends, sides grooved 1″ deep, 33° with vertical	Centrally	59,180	59,180	1,983	1,983	....
..	20	..	"	"	"	74,000	75,900	2,480	2,540	2,248
..	..	32	"	"	"	66,290	66,290	2,220	2,220	....
9	..	..	"	Square end, sides grooved 1″ deep, 45° with vertical	"	54,590	54,590	1,865	1,865	....
..	21	..	"	"	"	72,350	72,350	2,460	2,460	2,322
..	..	33	"	"	"	77,400	77,400	2,640	2,640	....
10	..	..	"	Beveled ends, plain sides	Eccentrically 1½″	40,120	40,120	2,970	2,970	....
..	22	..	"	"	"	39,890	39,890	2,950	2,950	2,960
11	..	..	"	Beveled ends, sides grooved 1″ deep, 39° with vertical	"	40,220	40,220	2,980	2,980	....
..	23	..	"	"	"	41,180	41,180	3,050	3,050	3,015
12	..	..	"	Beveled ends, sides grooved 1″ deep, 33° with vertical	"	40,600	40,600	3,010	3,010	....
..	24	..	"	"	"	39,000	4,145	2,890	3,070	3,040

fiber by about 20% at the crown and 35% at the springing. Allowance has been made for this eccentricity in computing the tabular stresses. As previously explained, the concrete was deposited in layers and the splitting was encouraged by this fact.

Arch No. 3 failed and collapsed suddenly by crushing at the joint between rib and key at the springing. This arch was accidentally overturned and broken when an adjacent arch failed. It was put together and tested. The contact at the joints was necessarily imperfect and this somewhat accounts for the lower ultimate resistance of this arch, as compared with the others.

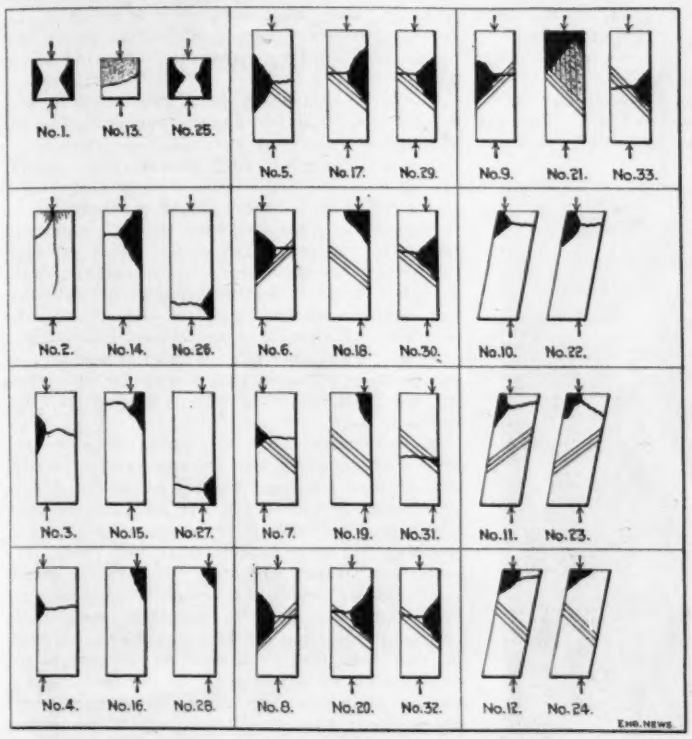


FIG. 5. DIAGRAM SHOWING KINDS OF FAILURE OF CONCRETE PRISMS UNDER COMPRESSION.

Arch No. 4, one of the three reduced in section, failed by crushing at the joints between rib and keys at the springing and collapsed suddenly. Before the test began it was seen that the area of contact at these joints was very much reduced by imperfect workmanship. The tabular stress was based on the eccentricity of the reduced sections.

Arch No. 5 was one of those reduced in section. It failed by crushing between the reduced section and the adjacent joint and collapsed suddenly. After failure began, the rib twisted forward and cracked, as shown in plan (Fig. 4).

Arch No. 6 was also one of those of reduced section. The first sign of failure was a crack along the axis just above the key at the springing. This crack grew wider rapidly; it was quickly followed by crushing at the reduced section and a complete collapse.

Six 6-in. cubes were cast of arch material at the time the ribs were cast. They showed an average ultimate strength in compression, at 28 days, of 2,080 lbs. per sq. in. These tests were not entirely satisfactory and are not to be accepted as conclusive.

Column and Cube Tests.

The results of tests on columns and cubes are shown in the accompanying table (Table II). This is supplemented by a diagram (Fig. 5). In computing the tabular stresses it has been assumed that a straight line distribution of stress obtains and, except where the maximum unit tension is small, that the concrete takes no tension whatever. That the former assumption is incorrect, due to the variation of the modulus of elasticity with variation of stress intensity, is clearly indicated by the fact that the maximum calculated resistance of plain-sided prisms with 1 in. eccentricity is 34% greater and with 2 ins. eccentricity is 50% greater than with similar prisms centrally loaded. The average calculated resistance for six prisms, both with and without grooves, all having 1½ ins. eccentricity is 44% greater than the plain-sided prisms centrally loaded.

The theory of distribution of stress in the grooved prisms is complex and the tabular stresses are approximate only, having been computed from the moment of resistance of a plane at right angles to the axis at the point where failure occurred.

Test specimen No. 2, failed at a low load by splitting, on account of the use of too thin a cap plate (Fig. 3). Hardened steel plates 2 ins. thick were used on all other prisms.

Much care was taken to secure the greatest possible uniformity in the character of the test specimens. It will doubtless be of interest to notice the great uniformity of the tests, as shown by prisms, No. 10 and 22; Nos. 11 and 23 and Nos. 12 and 24.

The value of these tests does not lie in the absolute values obtained in resistance to compression, but in the general conclusions indicated, namely, (1) that, if a straight line distribution be assumed, the working unit stress on the extreme fibre, when the line of pressure passes at the edge of the middle third, may be considered as at least 30% higher than the allowable working stress, when the line of pressure lies on the neutral axis; this will undoubtedly be as true for arches as for prisms; (2) that, if reasonable values can be chosen for unit stresses in compression, no account need be taken of so-called shear for an arch rib or column sustaining a thrust parallel or nearly parallel to the axis.

Final values of working unit stresses will not be chosen until the second series of tests on both arches and prisms are completed.

These tests were carried on under the authority of the State Engineer, Frank M. Williams. Their scope was determined by Wm. R. Davis, Chief Bridge Designer, and their execution was under the immediate supervision of Russell S. Greenman, Resident Engineer in charge of the Testing Laboratory, with the assistance in planning and executing of Harlan D. Miller, Bridge Designer.

THE PERCENTAGE OF STREET RAILWAY EARNings paid to the city of Toronto by the Toronto Railway Company for the year 1909 amounted to $507,827. In addition, the company paid the city $82,128 of pavement charges and $50,326 of general taxes, making a grand total of $640,281. The total payments of the company to the city since the beginning of the franchise period on Sept. 1, 1891, have amounted to $5,250,067. We are indebted to Mr. C. H. Rust, M. Am. Soc. C. E., City Engineer of Toronto, for the foregoing information.

A Method for a Long Span and Light Floor Reinforced-Concrete Construction.*

By EMILE G. PERROT†

While there has been no doubt of the economy and practicability of reinforced concrete for massive construction and where heavy loads are carried, the advisability of its use for light floor loads, especially if the spans are long, has been questioned even by those who favor its use in other instances. The dead weight of the material itself has often operated against its use, especially where the carrying capacity of the soil required the unit pressure to be kept to the minimum, or from other like causes.

We all agree that clear spans of forty or fifty feet in buildings are not usual and are generally avoided on account of their increased cost; hence a description of such a span, with its cost as compared with steel girder construction for the same span, is of interest.

While the author does not wish to take any credit for originality in the design of this floor, as the same general scheme has been used many times before for shorter spans, it is because of the unusual length of the span that its details become an important factor in the design.

The spans in question form the floors over the swimming pool and gymnasium of the Turngemeinde Club House, Philadelphia, and are 53 ft. 1⅞ ins. clear span.

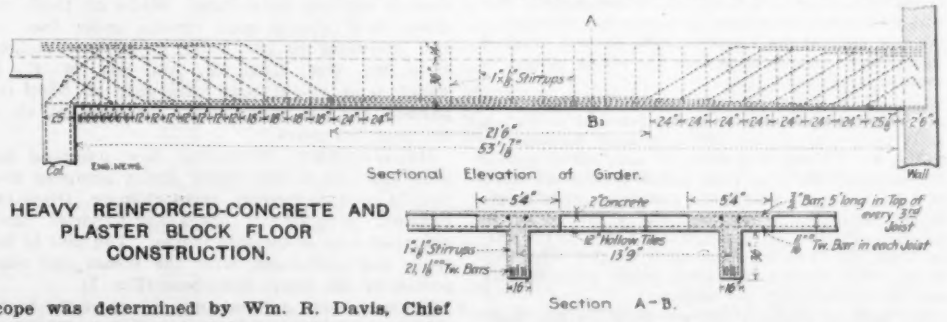
There are two floors with these spans, of an area of about 4,700 sq. ft. each, having five girders on the first floor and six on the second floor, spaced 13 ft. 9 ins. c. to c. Those of the first floor are only 36 ins. deep below the joist, on account of head room. The top portion or T-head is 5 ft. 4 ins. wide and 14 ins. thick. These girders are reinforced with twenty-one 1⅛-in. square twisted bars, bent as shown in the figure. The stirrups are 1 × 1½-in. flat iron, bent and spaced as shown. Great care was taken to place the bars accurately in position, and the bottom bars were supported in the bottom of the molds on cast cement chairs, while the spacing of the bars and stirrups was maintained by iron rods and the wiring of one bar to the other.

The floor panels between the girders consist of 5 × 12-in. concrete joists, with a 2-in. reinforced-concrete slab over same, and 12 × 12-in. plaster block centers between each joist, thus making a flat ceiling between girders. The joists are reinforced with one 11/16-in. square twisted bars and eight ¼-in. stirrups. In the top of every third joist were placed two ¾-in. square twisted bars over the girders to act as a tie. These rods were only five feet long, but two were used in each case, lapped in the center so as to project beyond the T-head into the joists. The slab is reinforced with ¼-in. rods run in both directions, 12 ins. on centers or thereabouts.

The girders supporting the auditorium floor, on account of the higher ceiling, are 42 ins. deep, with T-head, 4 ft. 9 ins. wide. The reinforcement in the bottom consists of eighteen 1⅛-in. square twisted bars, bent the same as shown for first floor.

Each floor is designed for a live load of 120 lbs. per sq. ft., as the top floor is an auditorium and the floor below a gymnasium.

There seemed to be some doubt amongst the members of the Building Committee as to the advisability of constructing such long spans of reinforced-concrete, and one of the Committee went so far as to offer to increase his subscription to the building fund by a very large amount in order to pay for steel girders, but the amount offered was insufficient to pay the extra cost, so the girders were built as originally designed, of reinforced concrete. In order to obtain the actual difference in cost, we designed the girders of Bethlehem steel girder sections, reinforced with top and bottom cover plates and fireproofed. The girders were 30 ins. deep, 200 lbs. per foot, with two cover plates on each flange, one ⅝ × 15 ins. and one ½ × 15 ins. We obtained bids from the building contractor for the difference in cost of these girders, we having likewise made an esti-



A HEAVY REINFORCED-CONCRETE AND PLASTER BLOCK FLOOR CONSTRUCTION.

*Paper presented at the Annual Meeting of the National Association of Cement Users, Chicago, Feb. 21-25, 1910.

†Baillinger & Perrot, Architects and Engineers, Philadelphia, Pa.

mate of the difference in cost. The contractor's price for them was $6,500 additional to his contract price, although our estimate of the difference was somewhat less, being $4,664, based on prices obtained from outside sources. Taking our figures as a basis, as there are 5,400 sq. ft. in the two floors, the difference in cost for the structural steel, fireproofed, is 50 cts. per sq. ft. more than the reinforced concrete, with no increased advantage.

The weight of the structural steel for a girder as compared to the weight of reinforcing steel is as follows:

Total weight of steel girders, with strap iron reinforcement for fireproofing and bearing plate, about 17,000 lbs.

Total weight of reinforcing steel in one reinforced-concrete girder, 36 ins. deep, 5,500 lbs.

This shows that it takes about one-third the amount of steel for reinforced concrete as compared with structural steel for girders and beams. The amount of saving in concrete would be the overhanging portions of the T-head, which amounts to 2¼ cu. yds. per beam, when the extra thickness of concrete on the girders is taken into account due to the wide flanges on the steel girders; likewise there would be additional plaster blocks necessary to take the place of the T-head omitted, the cost of which would have to be deducted from the saving effected by omitting the T-head.

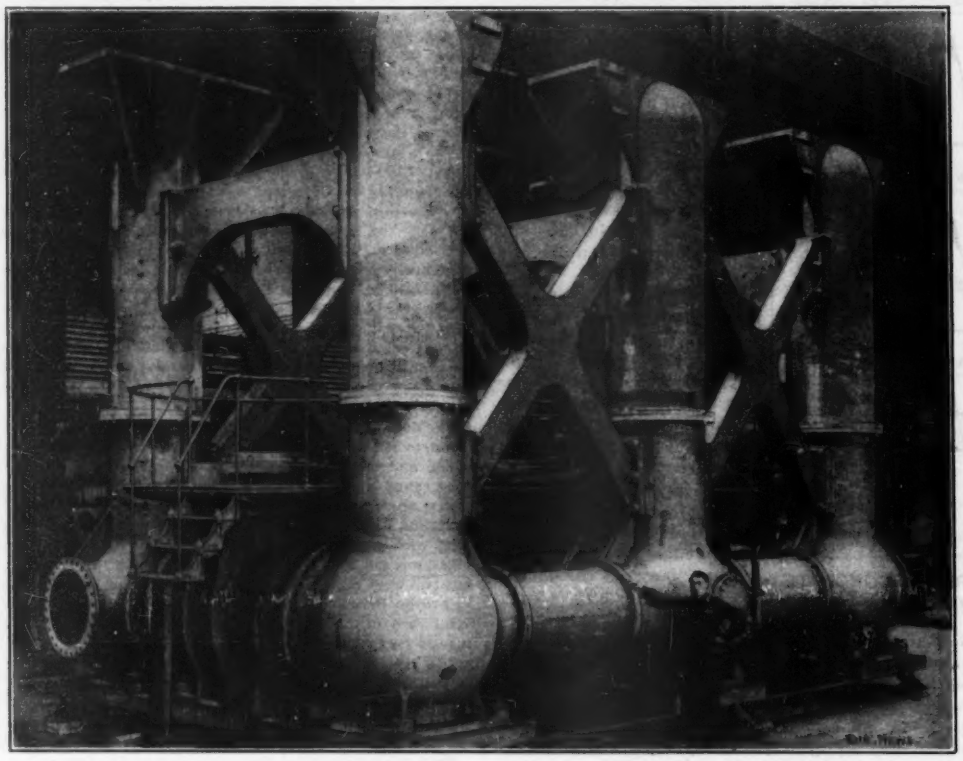


FIG. 1. WATER END OF PUMPING ENGINE OF 12,000,000 GALS. CAPACITY FOR MILWAUKEE, WIS.
(The steam end is supported directly upon the water chambers.)
Allis-Chalmers Co., Milwaukee, Wis., Builders.

The sub-contractor for the reinforced-concrete work gave the cost of the plaster blocks, delivered at the job, as 14 cts. per sq. ft., and setting of same, including the nailing on of a fine wire screen at each end to prevent the concrete running into the hollow part of the block, as 3 cts. per sq. ft. additional. The plaster block weighs 25 lbs. per sq. ft., as compared with 40 lbs. per sq. ft. for terra cotta tile, which cost the same price as the plaster block, but which are not as easily handled, being only 12 ins. long, whereas the plaster blocks are 3 ft. long and can be sawed to fit any position.

The walls of plaster blocks are about 1½ ins. thick, and there are two cells in each block, separated by a vertical wall in the middle which strengthens the block, so that traffic can take place over them before and during the time of pouring the concrete.

Immediately before pouring the concrete, it is necessary to thoroughly soak the plaster blocks with water, as they absorb a considerable quantity of water from the concrete if not thoroughly wetted; in fact the parts of the floor where the blocks occur and where they do not, are clearly marked during the earlier stages of the setting of the concrete by the difference in its color, the concrete which does not come in contact with the plaster requiring more time to set.

For moderate spans, the use of concrete joists with either the plaster block or tile filler are desirable, where a flat ceiling is sought and the load light.

High-Duty Pumping Engines at Milwaukee, Wis., and Nashville, Tenn.

The design and tests of two pumping engines of 20,000,000 gals. capacity in the North Point pumping station works at Milwaukee, Wis., were described in our issue of Feb. 3, and one of the special features of the plant was the high station duty maintained during regular service. Since these engines were installed (by the Wisconsin Engine Co., of Corliss, Wis.) the city has awarded contracts for two 12,000,000-gal. engines for the same station to the Allis-Chalmers Co., of Milwaukee, Wis., and one of these has been completed and tested (as noted in our correspondence columns this week). To Mr. W. J. Sando, Manager of the pumping engine department of this latter company, we are indebted for particulars of the new Milwaukee engines and of a new engine at Nashville, Tenn., with records of their duty tests. While all these engines have shown good results under test we call attention to the letter in another column from Mr. Wm. Kent, M. Am. Soc. M. E., in which it is stated that "the duty of triple-expansion engines has scarcely increased at all in the past ten years."

MILWAUKEE, WIS.—The new pumping engine (No. 7) at the North Point pumping station is of the vertical, three-cylinder, triple-expansion, condensing, crank-and-flywheel type, equipped with automatic valves. The unit is entirely self contained, with the steam end supported by the pump chambers (Fig. 1).

The admission and exhaust valves of the high-pressure cylinder and the admission valves of the intermediate-pressure cylinder are of the Corliss type, while the exhaust valve of the intermediate-pressure cylinder and the admission and exhaust valves of the low-pressure cylinder are of the poppet type. A standard speed governor of the centrifugal type, driven by belt from the engine shaft, controls the cut-off of the high-pressure cylinder through the long-range Corliss valve gear. The cut-offs of the intermediate cylinder are controlled by hand-adjusted mechanism.

Each of the steam cylinders is jacketed, and the arrangement adopted is considered to make the fullest use possible of the heat contained in the steam, and at the same time to remove all need of jacket regulation which is necessary when other arrangements are followed. The high-pressure cylinder jacket receives steam through a by-pass around the throttle valve. The condensation from this jacket is trapped out and delivered to the jacket of the low-pressure cylinder where (at the reduced pressure) it is capable of giving up further heat. The steam supply for the intermediate cylinder is taken from the first receiver. The condensation is trapped out and delivered to the low-pressure cylinder jacket, which also receives steam from the second receiver. The condensation from this jacket is drained to a trap and delivered to the hot well.

A surface condenser with large cooling surface is placed in the suction connection to the pumps and maintains a satisfactory vacuum.

The three single-acting pumps, with outside packed plungers, are located directly beneath the steam cylinders. Each plunger is connected by means of four vertical rods to the cross head carried by the piston rod of the steam cylinder. The pumps are designed for a direct and uninterrupted flow of water through the chamber, with no reversal of motion of the water. The sectional area through the valves and all sections of the chamber is such as to permit of very low velocity. The suction supply for the pump is taken from the main conduit leading from the intake crib.

The accompanying table gives the more important observations and the results of a 24-hour test of this pumping engine, conducted jointly by representatives of the city and the builders. It will be observed that the guaranteed duty was exceeded by over 10,000,000 ft.-lbs., while the amount of water delivered was nearly 500,000 gals. greater than the contract requirement. The engine had been in operation some three months at the time the test was made, but during that time there had been no changes in the valve setting or adjustment. In the result of the test no allowance was made for any moisture which might have been contained in the steam and it was assumed to be dry. No attempt was made to run a complete boiler test at the time the engine was tested, but a record was kept of the coal consumed and the ash discharged.

NASHVILLE, TENN.—The high-duty pumping engine recently installed is of the same type as the Milwaukee engine above described, but of larger size. It has a capacity of 20,000,000 gals. per 24 hours against a head of 385 ft., and is for deep pit pumping. The height from the bed plate under the pumps to the top of the cylinder heads is 98 ft. 10 ins. Owing to local conditions this unit has certain features of design which are particularly interesting. The engine is installed in a pit which was occupied by an older engine. This pit has a minimum cross-section 12 × 46 ft., which limited the room available for apparatus and made necessary a special design throughout.

The steam end is supported by an independent foundation at the top of the pit. The steam cylinders are all jacketed and the connections of the jackets are the same as those described for the Milwaukee engines. The admission and exhaust valves of the high-pressure cylinder and the admission valves of the intermediate pressure cylinder are of the Corliss type, operated by long range valve gear. The exhaust of the intermediate cylinder, and the admission and exhaust valves of the low-pressure cylinder, are of the poppet type. The valves are operated by separate eccentrics.

The pump is set at the bottom of the pit, which is 60 ft. 8 ins. deep. The three pump chambers, which are made of cast steel, are connected to two valve chambers located above and between them. Th discharge from the middle pump is delivered to both of the valve chambers. These unite in a common discharge. Above each valve chamber is placed an air cylinder of riveted plate construction (Fig. 2). Four steel rods connect each crosshead to the plunger head, which in turn is connected to the plunger proper by sections of special cast-iron pipe 20 ins. diameter. This makes a very rigid connection, and

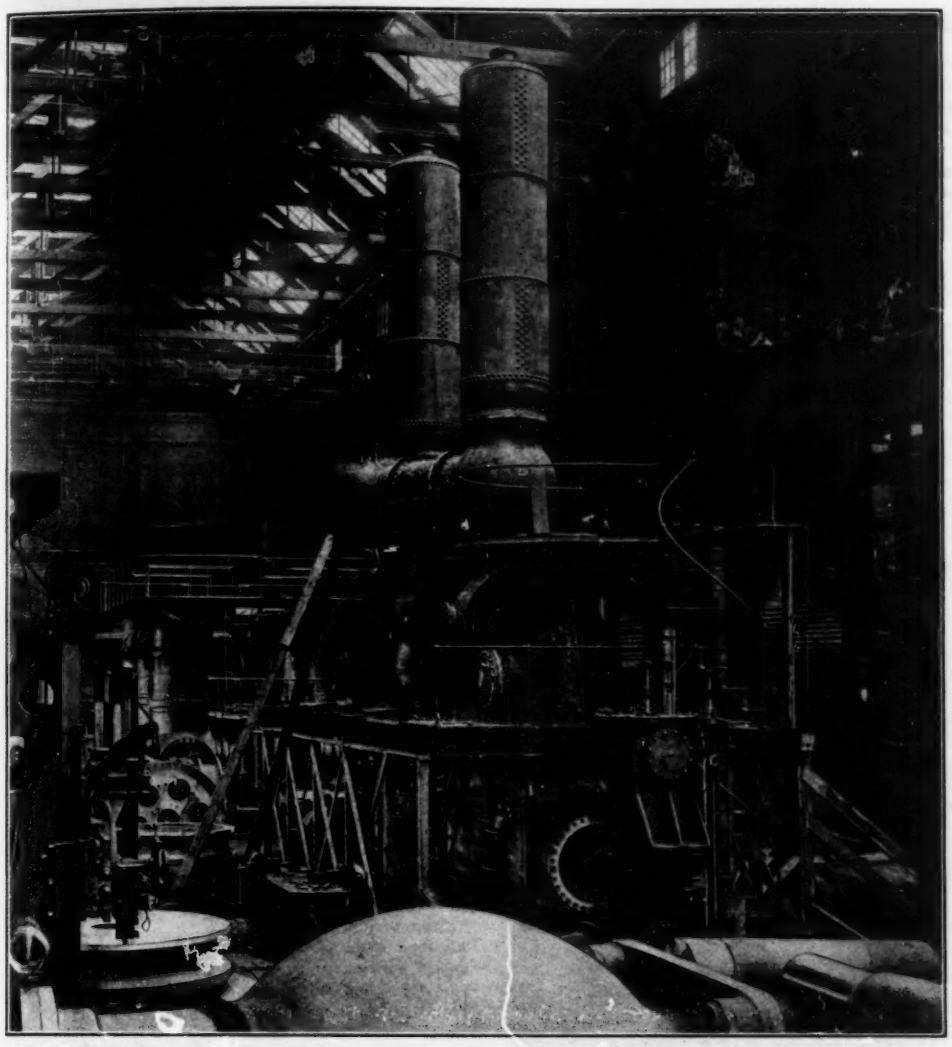


FIG. 2. WATER END OF DEEP-PIT PUMPING ENGINE OF 20,000,000 GALS. CAPACITY FOR NASHVILLE, TENN.

(The steam end has independent supports on the pump-pit, and the air chambers are of riveted construction.)

Allis-Chalmers Co., Milwaukee, Wis., Builders.

DUTY TESTS OF PUMPING ENGINES AT MILWAUKEE, WIS., AND NASHVILLE, TENN.

	Milwaukee.	Nashville.
Date of test	Jan. 4, 5, 1910.	Dec. 21, 1909.
Duration of test (hours)	24	10
Rated capacity per 24 hours, gals.	12,000,000	20,000,000
Diameter, H.P. cylinder, ins.	30	36
Diameter, int. cylinder, ins.	54	70
Diameter, l.p. cylinder, ins.	80	106
Diameter plungers, ins.	26½	31
Stroke of plungers and engine, ins.	60	72
Ratio of cylinders	1 to 3.24 to 7.11	1 to 3.77 to 8.65
Cooling surface of condenser, sq. ft.	1,350	2,500
Ave. steam pressure, lbs. per sq. in., gage	.....	.....
High-press. cylinder	124.6	164.6
1st receiver	34.95	35.9
2nd receiver	3.38	0.833
Vacuum by gage, ins.	28.73	29.0
Barometer, average, ins.	29.38	.....
Average net head pumped against	121 lbs.	385 ft.
Revs. per minute, average	20.42	19.92
Piston speed, ft. per min.	204.2	239.04
Water pumped during test, total, gals.	12,430,000	8,434,471
Water pumped, equivalent for 24 hours	12,430,000	20,203,000
Condensed steam used by engine, total, lbs.	165,554	146,885
Ave. I.-HP., high-press. cyl.	206.7	.....
Intermed. cylinder	198.85	.....
Low-press. cylinder	231.8	.....
Total	637.35	.....
Ave. delivered HP.	618.00	.....
Mechanical efficiency, %	97.1	.....
Steam per I.HP. per hour, lbs.	10.82	.....
Steam per del. HP. per hour, lbs.	11.15	.....
Ave. B.T.U. per I.HP. per min.	209	.....
Ave. B.T.U per del. HP. per min.	216	.....
Moisture in steam	(dry)	1%
Steam per hour, lbs.	.....	14,688.50
Net dry steam per hour, lbs.	.....	14,541.62
Total coal burned (24 hours), lbs.	21,574*	.....
Total ashes and clinkers, lbs.	2,362	.....
Total combustible, lbs.	19,212	.....
Coal per I.-HP. per hour, lbs.	1.41	.....
Temp. of feed water entering boiler	92° F.	.....
Duty per 1,000 lbs. dry steam, ft.-lbs.	175,400,000	184,700,000
Duty per million B.T.U.	151,000,000	.....
Thermal efficiency	20.25	.....
Evaporation per lb. coal	7.67	.....
Evaporation per lb. combustible	8.62	.....
Duty per 100 lbs. coal	134,500.00	.....
Duty per 100 lbs. combustible	151,200,000	.....

*Pocahontas mine run.

is also as light a connection as could be devised.

Owing to the lack of room and the distance of the suction line from the steam cylinders, it was not deemed advisable to put the surface condenser in the suction line, so it was placed in the discharge line at a height of 34 ft. above the suction inlet. The air pumps and feed pumps are at about the same level.

The official test of this pumping engine, covering a period of ten hours (10 a. m. to 8 p. m.) was made under the supervision of the chief engineer of water-works (Mr. Geo. Reyer), acting for the city. All readings were taken by a squad from the senior class of Vanderbilt University which had been assigned to the work. Representatives of the builders checked the observations. The primary object of the test was to determine whether or not the pumping engine met the guarantee of 20,000,000 gals. per 24 hours with a duty of 175,000,000 ft.-lbs. per 1,000 lbs. of dry steam, and no attempt was made to secure readings which might cover other possible phases of such a test.

A summary of the more important readings and the results of the test are given in the accompanying table. The duty obtained far exceeded that guaranteed, and is said to be much greater than ever before obtained under like conditions with moist or saturated steam.

Two Severe Storms in Northern Luzon, P. I.

By JOSE ALGUE.*

During October, 1909, two very severe typhoons of typical character crossed the Island of Luzon at a considerable distance north of Manila. The following are the main facts concerning these storms:

TYPHOON OF OCT. 14-19, 1909.—This typhoon belonged to Type VI. of the classification of Far Eastern rotary storms. This type of typhoons usually occurs from July to October. These storms have their origin far out in the Pacific Ocean and, traveling on a WNW course, cross north of Manila between parallels 15° and 20°, and enter the Asiatic Continent after having traversed the northern part of the China Sea (see "The Cyclones of the Far East," page 93 and Plates XXII. and XXIII.).

The first indications of an atmospheric disturbance in the Pacific were received from Yap Island as early as Oct. 12. Subsequent cablegrams from the observers on Guam and Yap on Oct. 13, 14 and 15 showed the existence of a typhoon, first between Yap and Guam and then between Yap and the Philippine Archipelago.

The first warning concerning the approaching storm was cabled by Manila Observatory to the Central Observatories of Tokyo, Zikawei, Taihoku, Honkong and Phulien on Oct. 14. In the morning of the 16th the storm center lay east of Luzon, at a distance of about 500 miles from the Island, and was moving WNW. In the afternoon of the 17th the vortex entered Luzon and crossed the island, passing between Aparri and Tuguegarao. Retaining its WNW direction in the China Sea, the disturbance reached the Asiatic Continent to the south of Macao, not far from this Portuguese colony.

The lowest atmospheric pressure recorded during the passage of this storm across Luzon was registered at Aparri at 8.30 p. m. of the 17th, viz., 710.8 mm. (27.98 ins.). Unfortunately there was no meteorological station within the zone traversed by the vortex.

On the 17th the area of rain covered the entire Island of Luzon, the heaviest precipitation occurring in the mountain regions. The total amount of rainfall at Baguio, Benguet, at an altitude of 1,502 m. (4,960 ft.) was 689.7 mm. (27.15 ins.) on the 17th. Baguio lay about 120 miles south of the trajectory.

The wind attained hurricane force over an area of approximately 260 miles radius around the center. The greatest velocity recorded at Baguio was at the rate of 97 mi. per hr. during

*Director of the Philippine Weather Bureau, Manila, P. I.

a squall lasting only a few minutes, and over 70 mi. per hr. for several hours.

TYPHOON OF OCT. 20-25, 1909.—This typhoon belonged likewise to Type VI. Its track was similar to that of the preceding storm, except that it crossed Luzon nearly 150 miles farther south.

Like the preceding, this storm was signaled from Yap about three days before it struck Luzon. Warning of its coming was cabled to the various Meteorological Services of the Far East on the 22d, and in the early morning of the 24th the disturbance crossed Luzon on a WNW track which lay between Dagupan and Tarlac.

The lowest barometer was registered in Tarlac at 5 a. m. of the 24th, being 735.2 mm. (28.94 ins.).

The rainfall was far less heavy than on the occasion of the preceding typhoon, the largest recorded being that of San Isidro, nearly 30 miles south of the trajectory, to wit, 228.6 mm. (8.97 ins.).

The wind reached its greatest force within an area of about 50 miles around the vortex. The maximum velocity was recorded at Dagupan, being at the rate of 90 mi. per hr. for a few minutes. Hurricane winds lasted for a few hours.

With regard to the heavy rainfall in July, 1904, mentioned by one of your correspondents writing to you from Silver City, N. M., under date of Oct. 27, 1909, I beg to say that it was the heaviest ever recorded in Manila since the foundation of Manila Observatory in 1865, viz., 436.6 mm. (17.19 ins.) from 8 a. m. of July 12, to 11 a. m. of the 13th, 1904. But as regards Baguio, the record is held by the rainfall of Oct. 17, 1909, which was 689.32 mm. (27.19 ins.) in one day. This is in excess of the average *annual* precipitation in Denver, Los Angeles, Sacramento, Salt Lake City, San Francisco and Santa Fe.

Some Answers to Examination Questions.

A professor in a prominent engineering school has sent us the following remarkable answers gleaned from the papers turned in by his students after an examination in "Kinematics" and "Mechanics of Machinery." He remarks in forwarding them: "It may be thought that the answers reflect on the teacher as well as on the pupils; but I can assure you, the former did his best!"

The answers are as follows:

An eccentric is nothing more than a crank which is made all over the piston-rod.

Acceleration is the moment of a body from its highest point to a state of rest.

A locomotive has no flywheel because it must stop at stations.

A locomotive has no flywheel because it must run both ways.

A manhole in a boiler is made elliptical so that the coal may be easily shoveled in.

Large flywheels are made in segments because they could not melt enough iron at one time to cast a whole one.

A *boidt* in a riveted joint is an example of a *peace* in both *sheer* and *tention* at the same time.

The condition of positive driving is that the line of the axis does not intersect.

A connecting rod is made of steel because it has both contraction and expansion which must be resisted.

Angular velocity ratio is the whirling in a circle as of a weight on a string.

The condition of purg rolling is that the point of contact must not slip.

An eccentric is used for valve-gears instead of a crank to avoid the jerky and uneven motion of the latter which would cause the valve to work wrongly.

THE WIDTH OF COAL necessary to protect an oil well was brought before a Pittsburg court recently. The suit was a friendly one, between the Pittsburg Coal Co. and the owners of oil wells piercing the coal measures, to obtain a judicial ruling as to how wide a pillar of coal must be left unmined around a gas or oil well. The mine inspectors have hitherto required the coal to be undisturbed for at least 20 ft. each way from an oil well. The coal company claims this is a needlessly large allowance. The court appointed an expert commission, made up of Messrs. Jas. Blick, Daniel Boden and Geo. W. Muse, to investigate and report upon the question as it arises in the coal seams at Forest Hill.

Luminous Repeating or Advance-Indicating Railway Signals.

Luminous repeating or advance-indicating signals as a safeguard during fogs are in use on the high-speed Brussels-Antwerp line of the Belgian State Railways, the system having been installed in June, 1908. These signals are placed at approximately the height of the eye of the engineman in the cab. During the foggy season of November, 1908, there was no case of a train over-running a block signal, while in November, 1907, there were 25 such cases. Audible signals have been installed experimentally, but it is expected that they will constitute a nuisance near towns.

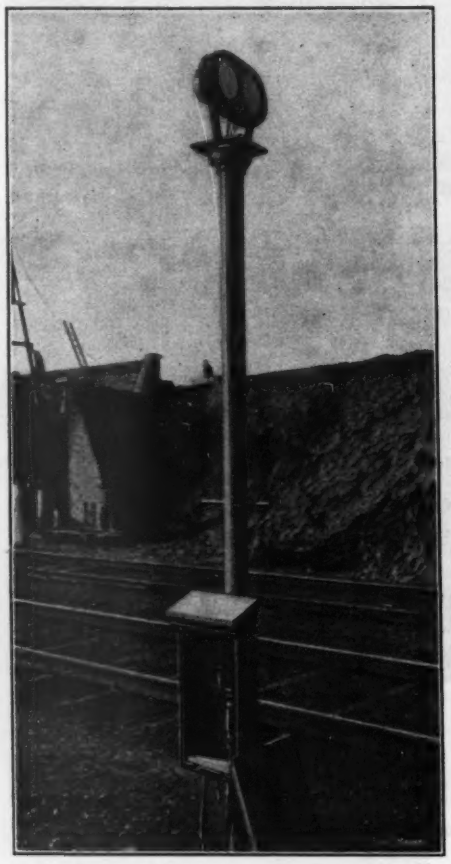


Fig. 2. Advance Repeating Lamp at Block Signal; Belgian State Railways.

In the block signal system adopted by the Belgian State Railways, the home signal is placed 328 ft. in advance of the danger point (or end of the block), and the distant signal is placed 2,624 ft. from the home signal (on level track). The distant signal shows a green light when the former is at the "clear" position, and an orange-yellow light when the former is at the "stop" position. To attract the enginemen's attention to the distant signal, it is preceded by five horizontal bars placed diagonally to the track; these are beams 16½ ft. long, painted white, or white enameled plates attached to posts. These signs are 165 ft. apart, and the last one is 165 ft. from the distant signal. At night the headlight on the engine makes these white marks sufficiently conspicuous.

Trials were made with different systems of indicating lamps, and the system adopted consists of three lamps in front of the distant signal, and two in front of the home signal. These show green or yellow lights according to the position of the signal. They are spaced 500 ft. apart and 500 ft. from the signals, as shown in Fig. 1. Thus, if an engineman should miss the distant signal and its indicators, he has still two indicator lamps to warn him of his approach to the home signal. Each signal has two lamps in a lantern or case fitted with two lenses (one green and one yellow), and each lamp has a powerful reflector. The circuits are so arranged that only one lamp can be lighted at a time, so that the repeater shows a green light when the signal is at "clear," and a yellow light when the distant signal is at "caution" or the home signal at "stop." Fig. 2 is a view of one of the repeaters.

These repeaters or indicator lamps are lighted when the signals are obscured at a distance of 660 ft. to 1,100 ft. At junctions, each repeater would have two lamps side by side, supported by a bracket on top of the post. The lamps are placed 6 ft. 6¾ ins. above the rail and 5 ft. from the rail; where double lights are used they are 3 ft. apart (in a line at right angles to the track).

It appears from the description that the system is used only at blocks protecting the approach to stations. On the Brussels-Antwerp line (27.3 miles) there are electric lighting plants at both ends and at the middle, so that the supply of current was readily available for the lamps. A storage battery is installed at each signal tower, so as to be independent of the source of supply. In order to ensure that the battery will be operative when needed, the distant signals are operated electrically from the battery. At most stations gas or electric light is available, but where this is not the case, the lighting of the oil lamps could be attended to by the signalman or a crossing watchman.

The original main line between Brussels and Antwerp is so obstructed by grade crossings, junctions, crossovers, bridges, etc., that the highest average speed of train between stops was only 33½ mi. per hr., owing to the frequent checks by signals. To improve these conditions it was decided to build an independent line at a higher-level for high-speed service only, and this has been completed from Brussels and Malines. In 1908, there were 120 trains daily between Brussels and Malines, and 116 between Malines and Antwerp, but at a junction point (Berchem) near Antwerp there were 186 trains daily. The average speed of the fast trains is now 44¾ mi. per hr. between stops, and will be increased to 49¾ mi. per hr. when a new bridge and rearrangement of tracks at Schaerbeck are completed. By special improvements to permit of high speed through Malines, the average speed between stops will be further increased to 54¾ mi. per hr., which is considered the maximum obtainable on a run of only 27.3 miles.

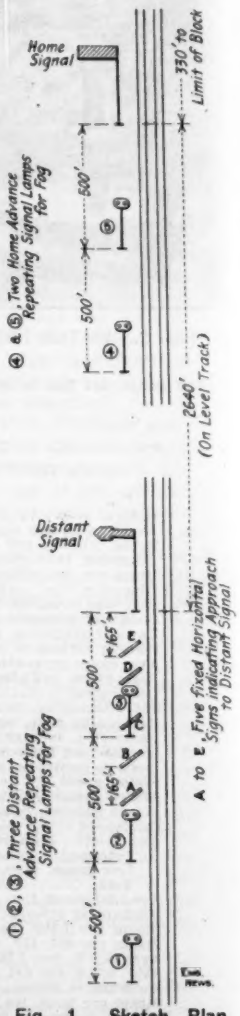


Fig. 1. Sketch Plan Showing Location of Advance Repeating Lamps for Use at Block Signals in Foggy Weather; Belgian State Railways.

This system of repeating signals is described at considerable length in a paper on "Luminous Repeating Signals for Fog," in the October number of the Bulletin of the International Railway Congress Association. The paper is by Mr. L. Weissenbruch, Chief Engineer of the Belgian State Railways, and Mr. J. Verdeyen, Assistant Engineer, who are at the head of the "safety appliances department" of this railway system.

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In the current discussion with reference to waterway improvement, the practice of European nations in waterway development is continually referred to, as if foreign engineers were a unit in favoring waterways as the most economical method of freight transportation. Actually, however, a brisk discussion is going on in Europe, and has, in fact, been going on for years, respecting the relative economy of rail and water transport.

A unique contribution to this discussion has recently been made by two German engineers, Dr. Walth. Rathenau and Prof. Wilhelm Cauer. They have published a monograph entitled "Massengüterbahnen (Railways for Bulky Goods)." The work is reviewed in the January "Bulletin of the International Railway Congress," the review being prepared by Louis Marlio, Engineer of Roads and Bridges. According to the reviewer, the authors of the book have attempted to solve the problem whether a railway designed especially for freight traffic would not be a cheaper means of transportation than a canal. They have therefore worked out plans and estimates for a freight-traffic railway of standard gage, with high-power locomotives and 50-ton cars. They estimate the cost of construction at either $100,000 or $200,000 per mile, according to the character of construction. This estimate seems enormous, of course, to American ideas, but it must be remembered that in an old settled country like Germany, very high costs must be allowed for land damages and for terminals. According to the reviewer, the estimated cost per ton-kilometer of carrying freight on the proposed railway would be from 1.4 mills to 2.4 mills. The final conclusion reached is that, comparing this proposed freight-traffic railway with a canal:

> the canal would cost 50% more from the standpoint of means of communication, 90% more from the standpoint of carrying equipment, 130% more from the standpoint of motive power, and that its capacity would be one-tenth as great.

The reviewer of the book does not question the correctness of this estimate regarding the relative economy of railways and canals, but he seriously questions whether it would be wise economy to build a railway for freight traffic only. He thinks that greater economy would be secured by adding to the trackage and traffic capacity of existing railways, and that in this way a lower cost of transportation would be secured than by building either a special line of railway or a canal. The correctness of this conclusion is fully confirmed by the present experience of American railways, which are already hauling bulk freights over long distances at rates which are as low as those estimated by the German engineers on a railway designed for freight traffic solely.

It is interesting to note, in connection with this theoretical design of German engineers, that the Canadian Government is giving serious consideration to a project for a freight-traffic railway to Hudson Bay, and surveys for it are being made this winter. A peculiar feature of this proposed line, is that it would have to be operated to the limit of its capacity for barely two months in the year, and for the remainder of the year there would hardly be enough traffic to warrant keeping the road open.

The only justification for the railway project is to carry to a shipping port on Hudson Bay the wheat produced in an immense district in the provinces of Saskatchewan and Alberta, equal in area to the states of North and South Dakota, Minnesota, Wisconsin, Nebraska and Iowa. Navigation in Hudson Bay can hardly be carried on for more than three months of the year, so the railway would have to haul all the wheat possible from the Northwestern farms to the shipping port in the very short time between the completion of the harvest and the close of navigation.

In the report on the project just issued, which we reviewed more fully on page 241 of our last issue, Mr. M. J. Butler, late Deputy Minister of Railways and Canals, presents an interesting discussion of the possibilities provided the line were operated to its fullest capacity. He assumes that all trains are fully loaded, are made up of cars carrying a net load of 40 tons and are hauled by Mallet locomotives with sufficient tractice power to handle 100 cars. At this rate he believes that 16 loaded trains per day could be handled over the single-track line. At this rate it is computed that 64,000,000 bushels of wheat could be delivered in 30 working days. If, however, it were attempted to operate the road with the heaviest type of ordinary locomotives, the traffic capacity would be immediately reduced to one-half that amount. Of course the operating expenses of a road where heavy traffic is confined to only two months of the year, would be enormous; but Mr. Butler suggests that if the road were operated by one of the great Canadian railway corporations, they could concentrate rolling-stock and operating force upon the line for the season of heavy traffic, drawing it from other parts of the system.

Controversies between street railway companies and municipalities have been common, and in many large cities they have reached acute conditions. They have been due in large measure to failure on the part of those controlling the companies to realize their proper relations to the public. This has resulted in attempts to secure excessive rights and privileges, and in a tendency to disregard the rights of the traveling public and of the municipality. It is true that in some cases municipalities have made unreasonable demands upon or interfered unreasonably with the companies, but in general such action has been inspired by a feeling of retaliation.

Such conditions have caused a general distrust of street railway and other public service corporations, and have led to a strong demand for municipal ownership of public utilities. It is, of course, very unfortunate that such conditions should exist, and no doubt such controversies will be greatly reduced in the future under improved methods of municipal government which are now being introduced. That the conditions have existed and do exist is tacitly acknowledged by the action of street railway associations in taking up an active policy for calming the public mind and restoring more harmonious relations.

Where cities have come into direct conflict with street railway companies, various systems of municipal purchase, and control, have been proposed. Sometimes municipal operation is included, but as a rule American cities will be content to own the lines, and to lease their operation to private companies under some system of public regulation. The approach of the expiration of franchises sometimes gives a city a strong position in compelling companies to agree to terms, as was the case in the closing of the 25 years of controversy in Chicago, reviewed at length elsewhere in this issue.

Until the settlement of the controversy at Chicago two or three years ago, the street railway system of that city had been notable for its deficiencies in regard to construction, equipment and service. For many years there had been increasing complaints from the public, and a continual fight between the city authorities on the one hand and the street railway companies on the other. The principal causes of the defective conditions, and of the controversies, were: (1) some of the lines had been controlled and manipulated for speculative purposes in a species of "high-finance" by which the revenues were diverted from their proper purposes, and when the properties were finally relinquished they were in a practically bankrupt condition; (2) the franchise question was a most complicated one, and there was great difference of opinion as to the dates of expiration of franchises covering various streets, owing to conflicting or vague provisions in various ordinances and laws passed from time to time. In addition to all this there were frequent charges of undue influences exerted by the street railway interests upon the city officials and the state legislators. In his annual message for 1906, Mayor Dunne (a strong opponent of the companies and an advocate for municipal ownership) stated that: "The history of the street railway problem in Chicago reeks with bribery, corruption and rottenness."

To guard against the evils of uncontrolled private street railways and to secure many, at least, of the benefits of municipal ownership without increasing undue financial obligations and great political risks, the city and the companies finally entered into a unique agreement under which the city is given a large measure of control of the financial and other operations of the companies, and 55% of the net receipts of the railways. The settlement contains many other provisions designed to protect and benefit the city and the companies. An examination of the contract provisions, and of the accounts of the means being employed to carry them out, all as given elsewhere in this issue, will show that the city occupies a strong position through these measures for controlling its street railway service. The interests of the company also seem to be well guarded. Under such conditions it may be expected that the street railway patrons will be well served, and that is or should be the grand object of all concerned.

Whatever one may think of municipal ownership of street railways as an academic question there seems to be little question but what under conditions existing at Chicago a continuation of private ownership with the addition of strong municipal control is far the better plan. When manifold other demands upon city funds have been met and still further progress has been made in municipal reform in Chicago it may become wise for the city to exercise the purchase options which its representatives had the wisdom to insert in the settlement contracts.

Almost as important and in some respects more unique than the Chicago street railway settlement is the termination of the long-standing street railway controversy at Cleveland, Ohio. The ordinance effecting that settlement, which was ratified by popular vote on Feb. 17, is abstracted at length elsewhere in this issue.

Perhaps the most striking difference between the Chicago and the Cleveland settlements is that Chicago seeks to make its municipal treas-

ury richer by taking to itself 55% of the net receipts of the street railway properties, while Cleveland, in harmony with Mayor Johnson's long 3-ct. fare campaign, aims to make and keep the fares as low as possible. Each city limits the undivided profits, as they may be termed, to substantially 6% on an agreed capital valuation and provides means for more or less city supervision of the affairs of the company as related to costs of construction and of service. Chicago takes a leading hand in the rehabilitation and extension of the street railway service, through a board of supervising engineers which designs and supervises new construction and has more or less control over capital outlay. Cleveland has a supervisory commissioner of street railways, with powers and duties as stated in our abstract.

Each city has made possible future municipal purchase at or near the agreed settlement valuation plus cost of extensions, and Cleveland has made elaborate provision for transferring its purchase option to private parties in case it is unable or unwilling to exercise it.

Contrary to popular understanding, at least outside of Cleveland, the 3-ct. fare already put in force in that city (with 1-ct. additional for a transfer) may be discontinued by the company after ten years, unless the city then extends the franchise beyond the 25-year term, but the maximum fare cannot exceed 4 cts. for a single cash fare, 7 tickets for 25 cts., and 1 ct. for a transfer; and on establishing the maximum fare the company must use a portion of its revenue in reducing its capital value. Such a reduction would be to the benefit of the city should it purchase the property of the company.

There may be strong reasons why Chicago should have chosen to give its taxpayers a share in the net profits of the street railway companies instead of reducing the fares paid by the patrons of the railways, as is provided for at Cleveland. On general principles, the Cleveland plan seems preferable. There is always something to be said for giving the municipal treasury some share in the profits of a franchise, but the practice tends to injustice to the patrons of the company.

Chicago has been working under its settlement plan long enough to show that it promises to fulfil the main object in view: the end of a long and bitter fight and the provision of ample street railway service. It also appears that the city will enjoy large revenues from the companies. The Cleveland plan went into effect on Feb. 19, 1910, so its working is still problematical. But even though fares may not be reduced below their initial level, or should they go up to the maximum, the city and people of Cleveland seem bound to gain by the settlement. Seven rides for 25 cts., with 1 ct. added for each transfer, which is the maximum rate under the new franchise, is better than the people of most cities enjoy.

It is noteworthy that the graded fare reduction plan put in force at Cleveland has as one of its intermediate steps a rebate of the 1-ct. transfer charge in case the transfer is used. The charge for a transfer in any case, with or without rebate, according to the fare plan in use at a given period, serves two purposes: (1) it checks the transfer abuse through dishonest practices on the part of the traveling public; and (2) it aids in making low fares possible. The nickel fare and universal transfer system has been quite in line with the American practice of charging a blanket price for an all-inclusive service, whether on a street railway or in a hotel, and in marked contrast with the European zone system of railway fares and moderate price for a room in a hotel with separate charges for such service (and such only) as may be actually rendered.

It is only fair to note that the heavy outlays for reconstruction of the Chicago street railways and the immense distances in that city tend to justify the continuation of 5-ct. fares, while at the same time the long-standing invitation caused by lack of transfers between different lines in that city goes far towards explaining why the free transfer system was included in the settlement.

Finally, it is to be noted that all the long years of controversy at Chicago and at Cleveland might have been avoided had the city authorities wisely guarded their interest from the start in all their dealings with the street railway companies and had the companies always considered and fulfilled their obligations to the public.

New England was for many years the section of the country where the independent railway corporation most flourished. In the period from 1830 to 1850, during which railway construction was most active, New England was the most densely populated part of the United States, as well as the most wealthy. Local capital was available in abundance, and all over New England railway corporations were organized and built roads, most of which carried on a local business only. Many of these small roads maintained an independent existence for twenty or thirty years, down to the era of railway consolidation which began in the 70's. During the closing decades of the 19th century the progress was very rapid in the absorption of these independent companies by the larger ones. The final act of the consolidation was the recent achievement of the New York, New Haven & Hartford Co. in securing practical control of the Boston & Maine system. As most of our readers doubtless know, the New York, New Haven & Hartford had acquired practically all the railway lines in Connecticut and Rhode Island, and in Massachusetts to the south and west of Boston, except the line of the Boston & Albany, which forms a part of the New York Central system. The Boston & Maine, on the other hand, had secured control of practically all the other railway lines of importance in the northern part of Massachusetts and in the states of Maine, New Hampshire and Vermont. The only exceptions to its control are the Rutland Railroad line through western Vermont to Canada, and the Central Vermont system, which is controlled by the Grand Trunk R. R. of Canada and extends through Vermont across Massachusetts and Connecticut to a terminus at New London, on Long Island Sound. The Grand Trunk has also a line across New Hampshire and Maine to a terminus at Portland. Neither of these Grand Trunk connections, however, can be said to interfere very much with the supremacy of the New York, New Haven & Hartford Co. in its control of the railway traffic of New England*

Just as the New England public has made up its mind to accept the situation of a single great corporation controlling the entire transportation interests which center at Boston, New England's "hub," the Grand Trunk Ry. Co. comes forward with a proposition to build a branch from its Central Vermont connection at or near Palmer, Mass., to a terminus at Providence. It is also said that another branch is contemplated by the Grand Trunk, to reach Boston.

The difficulties in carrying such a proposal into actual execution are extremely great. So far as the construction of the branch itself is concerned, the obstacles would hardly be serious, and it is said that sufficient local traffic could be secured to make the extension to Providence fairly profitable. Great difficulty would arise, however, in securing the necessary terminal facilities. When it is attempted to find space for an adequate railway terminal in such a city as Providence or Boston, the magnitude of the task is apparent. These cities are so closely built up and the land is so valuable that the necessary area of land alone, for a conveniently located terminal, represents an enormous investment.

Besides this, in the construction of any new railway terminal line in a large city, different standards must be met from those that would have been acceptable 50 years or even 25 years ago. Any such line, for example, would certainly be required to avoid all grade crossings in its entrance, and this means the construction of either elevated tracks or a subway. Of course a terminal on the outskirts of a city could be secured at relatively moderate expense; but experience has many times demonstrated that the handicap of such an inaccessible terminal is sufficient to ensure the failure of any railway enterprise relying upon it for its traffic facilities.

*In making the statements above, we are including the main lines only. There are still a few small branch roads owned by local capital and operated independently.

The paper on the "Unit System of Organization," printed on p. 242, of our last issue, records one of the most interesting departures in the management of a great business that has taken place in a long time. It is worth careful study and serious thought by every man who is responsible for or interested in the management of any large operation, and this includes, of course, very many engineers.

"The Unit System" is not a name which explains the new departure. We can better explain it by saying that the underlying idea of the new system is to unite the minor executive officers in working for the interest of the company instead of for the interest of the particular department of which they are the head. The evil which the new system aims to abolish is widespread. It permeates industrial establishments as well as railways. It weaves red tape in Government departments and sets different schools in a University warring against each other. The only concerns and institutions entirely free from it are those which are small enough to be controlled from one central office.

The plan which is being tried out on the Union Pacific is comparatively simple. It starts in by making all the minor division officers—the master mechanic, trainmaster, division engineer, chief dispatcher, etc.—Assistant Superintendents. It emphasizes that their duties to the Division are more important than their duties toward the particular line of work which they may be in charge. It promotes cordial cooperation between the different men and the departments of which they still retain direction. It cuts out red tape. The number of letters written has been reduced by 30% on some divisions, and when the reorganization has been extended over the whole system it is expected that the number of letters will be reduced by at least half a million a year.

We cannot add a more pertinent comment upon the plan than to quote the following sentences from Major Hine's address in describing the plan before the Western Railway Club:

> All this system claims is to reflect what is a general tendency to-day in organization, the world over in various lines of work. This system happens to be adapted to railway work on the Harriman Lines. The Navy has been going through a similar process. This system means in its last analysis decentralization. In nearly every line of activity to-day decentralization is the order. Four branches of Government work have been decentralized in the last year and a half. The National Bank Examiners have been decentralized, the Forestry Service has been divided into districts, the Post Office department has increased the number of its districts, the Quartermaster's Department of the Army has decentralized to a considerable extent. The big corporations like the telephone companies are introducing similar principles.

Some sensible remarks on water-works valuation may be found in a paper by Mr. John W. Alvord, M. Am. Soc. C. E., printed elsewhere in this issue. We particularly like what he says about the desirability of so framing franchise or other legislation governing the appointment of appraisers as to avoid partisanship, strife, and ill-feeling in the board, and finally throwing the valuation upon the third member. In Mr. Alvord's closing remarks, he makes what we believe will be a true prophecy to the effect that in the future water companies will see that their books show the real value of their property. To this end an appraisal may be necessary in some case to afford a starting point for proper valuation and depreciation accounting. Municipally-owned works would profit almost equally by the same methods, as true current values are needed for rate-making purposes under municipal as well as under private ownership.

The description of the tests on model arches recently made by the State Engineer of New York, as reported on another page of this issue, is of much greater interest as a preliminary statement of method than as an investigation of the stresses in masonry arches. When the details of manipulation are more familiar to the testing force it can be expected that the test

pieces will be of more uniform quality and the manner of carrying out the tests productive of more assured results. Meanwhile the experiments serve to call attention to the arch in the study of which they are being made.

In the first place this arch is to be larger in span than any now in use or in course of construction in this country. Its 285-ft. span is, however, passed by several arches in prospect, and by at least two in existence, the masonry arch at Plauen and the concrete arch at Auckland, N. Z. But aside from its span its distinguishing feature is the remarkably heavy load it has to bear. Aqueducts in the past have doubtless had to carry canals of an equal depth, but never in the history of construction has so deep a canal been carried over so long a span.

The dimensions, as given in this preliminary description, show a clear opening of 285 ft., a rise of 53 ft. 5 ins. and a width of 129 ft., carrying a canal of 13 ft. 2 ins. in depth. This load equals 825 lbs. per sq. ft. as against the ordinary 100 to 200 lbs. per sq. ft. used in arch bridge design. This is not strictly a live load because it cannot move across the bridge and cause a shifting of the line of pressure, but it is a live load in the sense that it can be gradually increased from zero up to its maximum, though such increase must be uniform across the bridge. Thus, there being no impact coefficient or shifting load, the ratio of 800 to 100 between the loads on this arch and an ordinary arch is in excess of the ratio of the stresses in the ring of the two arches but, nevertheless, the increase in loading above the normal is quite sufficient to make the engineers cautious in their design. Study of two of the largest concrete bridges in the United States shows the ratio of total live load to their total weight to be 1/17 and 1/13, respectively. The same ratio on the Medina arch is 1/3.7. Although this ratio is not as indicative of strength as would be ratio of total live load to total dead load of the arch ring alone, a ratio not now available for the arches in question, still the difference between the figures for the two old arches and for the proposed arch is most marked.

In masonry arch design heretofore it has always been accepted that, on account of the massiveness of the arch ring, it is impossible to get the ratio of live to dead load as low as in steel bridge design, but in the case of the Medina arch, it seems as though the standards of steel bridge practice would be closely approached.

The full dimensions of the arch are not given in the report, but the model would show the crown thickness to be about 72 ins. If the remainder of the ring is in proportion, the stress diagrams of the arch should be interesting.

As some of our readers may recall, we have spoken very plainly in these columns in times past concerning the crimes of "high finance" in connection with the street railway companies of New York City. A suit is now pending in the Federal Courts under which the Receiver of the New York City Ry. Co. seeks to recover from the Metropolitan Securities Co. and its Directors the sum of $2,797,200 lost from the City Railway's treasury between 1902 and 1904 by the discount of its ten-year notes at 70 and their early redemption at par. The individual defendants besides the Securities Company, are Thomas F. Ryan, Mortimer L. Schiff, P. A. B. Widener, John D. Crimmins, E. J. Berwind, Paul D. Cravath, H. H. Vreeland, Thomas Dolan and Thomas B. Fowler.

The Special Counsel for the plaintiff is Hon. Joseph H. Choate, now in his 78th year.

In summing up the case before the Court recently, Mr. Choate denounced the acts of the defendants in vigorous fashion. Some of our readers may think we have been too severe in our characterization of the street railway crimes committed in New York. We therefore reprint the following extracts from Mr. Choate's speech:

I think it was Mme. Roland who said, when on her way to the guillotine, "Oh, liberty, what crimes are committed in thy name." Well might these creditors have exclaimed: "Oh, high finance, what crimes are committed in thy name." The complete collapse only occurred in 1907, but the debauchery and corruption which had preceded it lasted through many years. I do not hesitate to say that the greatest financial enormity ever committed in New York was the flotation and inflation of the Metropolitan Street Railway, its securities and those of its subsidiary companies.

Just suppose that an individual undertakes to embark in a dangerous and hazardous enterprise, and in view of the character of his activities, puts $2,797,000 of his assets in the hands of his wife. And suppose his enterprise comes to its legitimate end, and a receiver is appointed to administer the property for the benefit of creditors and the bankrupt says, "I can't account for that money, I gave it to my wife, or my children, or else I hid it down cellar, or put it into a bicameral box. Why, your Honor, do you suppose that he would ever escape from the presence of the court until he had been forced to disgorge?

The defendants here are in exactly that position. They have taken, through this pretext of discounting notes, $2,979,000 of the assets of the City Railway and hid them away where the creditors of the City Company cannot reach them. They say they had a right to do this because the Securities Company was a holding company. Indeed, it was a holding company! It got a death grip in the City Railway, and held on so tight that it squeezed all the blood out of it, and finally, when this "debacle" came, it took away the City Company's life itself.

The facts are very simple. The Securities Company, as stockholder of the City Railway, had no right under the law to take away anything but the profits earned, if any. The fact that the two companies had common Boards of Directors makes it all the plainer that the trust relation existed which justifies this court in coming in to do equity.

They have made many explanations, but the trouble is that these explanations don't explain. The question still remains: Why [turning to Mr. Cravath] did you do it? Mr. Cravath here has made many explanations, but they are worse than none. He's very gallant about it, and comes bravely into the lists, with rueful countenance; with vizor down and spear at rest, he rushes upon us for the protection of his associates who don't care or don't dare to appear. He insists that there was nothing but the most honest intention.

Now, I don't dispute Mr. Cravath's good intentions. He may have had all the good intentions in the world, but we all know that very gloomy places are paved with good intentions. A court of equity doesn't stop with good intentions; it demands good faith. And I called Mr. Cravath in the course of the taking of testimony and asked him, not wanting to do him any injustice—asked him to explain. But the trouble with his testimony was that it didn't explain, but condemned.

They can talk all they want about Mr. Cravath and his reputation, and his firm, and Kuhn, Loeb & Co., but this court doesn't deal with words. What Mr. Cravath says all comes down in the end, when it is placed under analysis, to the assertion that there was a common identity between these two companies. He speaks of a mutual debt which it was desired to cancel, and a tax which it was desired to escape. Well, now just stop there for a moment and examine this special reason for the transfer of assets. There was going to be a tax fall due on Jan. 14 in a given year, and they wanted to get these assets shifted over to the other company where they couldn't be taxed.

Now, those explanations, while they show that these men knew what they were doing, don't apply to this case. I do not seek to do any injustice to Mr. Cravath, but all he is able to say is "community of interest," and that doesn't help at all. They cite many cases in which they claim it has been held that where one company owns another absolutely it makes no difference what is done with the assets of the company controlled; but those cases have a fatal defect, they all relate to companies where there are no creditors, and the presence of the creditors in this instance is what makes all the difference.

We have charged that the object of this discounting was to take $2,797,000 out of the assets of the City Railway Company. We charge further that the object of the agreements of May 22, 1907, was to take the rest. They had everything they possessed in hock and were much in the plight of the gambler who hocks his overcoat itself when he needs another meal. They refer to the agreements of May 22, 1907, as proving the payment of any obligation that might have existed by reason of the discount of the notes. But that can only be taken as meaning that there was an intention to pay. Can it be that they intended to pay back the City Railway for the assets of which it was deprived, these innocent lambs, who never dreamed that there was any claim created by the discount of the notes?

But hold, there were still a few of these notes outstanding then which they redeemed not at par, but at 70. Why was that when they had redeemed all the others at par? Mr. Cravath says it was because they were afraid of the Public Service Commission, that awful board that holds us all in terror. Then it must be that he advised them not to take any more—that it was time to stop.

A Handsome Tribute to the Reclamation Service.

The Senate has passed the bill providing for the issue of certificates to the amount of $30,000,000 for the benefit of the U. S. Reclamation Fund. The money raised by the issue of these certificates is to be applied solely to the completion of existing projects. The Senate in Committee of the Whole gave the bill thorough discussion, and while there was some difference of opinion over its details, there was no opposition to the measure itself.

We have heretofore referred to the statements which have been made that the Reclamation Service officers erred in judgment in undertaking work on a larger number of projects than could be completed within a reasonable time from the available income of the Reclamation Fund arising from the sale of public lands. These statements have had their influence, unquestionably. The San Francisco "Chronicle" of Feb. 26, for example, says:

Words almost fail to express the just indignation that the officials responsible for the conduct of the Reclamation Service should have recklessly begun projects enormously in excess of the ability of the fund to complete. Nothing more reprehensible has ever been done by any department of our Government. The Reclamation law was a wise one. It embodied the principle that the money received for public lands within the state should be expended for the benefit of that state, but the law did not contemplate that expenditures should grossly exceed the estimated revenues available.

But in the Senate debate it was frankly confessed that the real responsibility for this rested not on the Reclamation Service officials but on Congress itself. The original Reclamation law required the expenditures upon Reclamation work to be made in each state in approximate proportion to the revenues from public land sales in that state. Compliance with this clause of the law, moreover, was insisted upon. As Senator Jones of Washington said in the debate, "When the Reclamation Act was passed, every Senator and every Representative from the states affected pressed their claims upon the Reclamation Service just as strongly and just as urgently as possible."

The handsomest tribute to the Reclamation Service Engineers, however, was made by Senator Newlands, of Nevada. We reprint a portion of his remarks in the Senate on Feb. 17, as follows:

Mr. Newlands.—Mr. President, in the framing of the committee amendment to this bill an effort was made to limit the discretion of the Secretary of the Interior, which was ample under the original act, and to confine the expenditure of this money practically to projects already begun.

Individually I have been opposed to putting any limitation upon the discretion of the Secretary of the Interior. I think Congress acted wisely, in the first instance, in leaving the selection of these projects and the expenditure of the money to the Secretary of the Interior and the Reclamation Service organized by him. I think it would be wise to-day to maintain that large discretion.

It must be recollected that this discretion is not that of an individual. It is the discretion of a service, the great Reclamation Service, consisting of over 300 engineers. Probably the greatest engineering force in the world has been built up under the administration of different Secretaries of the Interior, under the leadership of Mr. Newell, the present Director of that service. The methods of selecting the projects are most discriminating. They have an engineer for each project. They have a supervising engineer, whose district embraces four or five or six projects. Whenever a project is under consideration the project engineer meets with the supervising engineer and with a board composed of all the supervising engineers, and all these matters are thoroughly thrashed out before they are presented to the Secretary of the Interior, the intervening judgment of the Director of the Reclamation Service being also secured.

So, a project is only entered upon after the most thorough examination of the region in which it is proposed to locate it, of all the elements of expenditures and cost and reimbursement of cost; and board after board will sit upon these projects in the various stages of their progress, and at every stage they have to pass the judgment of the Director of the Reclamation Service, and finally the judgment of the Secretary of the Interior himself.

When this bill was originally under consideration I thought that method was infinitely preferable to the method which had theretofore been employed in river and harbor work in this country, under which the selection of projects was left to the control and direction of

a political body, subjected to all the evils of the spoils instead of the merit system.

Now, this work has been done well. The projects for the most part have been wisely selected. Some mistakes have been made—not serious mistakes. Some mistakes have been made as the result of the extraordinary pressure brought to bear upon the Reclamation Service by the political representatives of the regions affected. Some mistakes may have been forced by the rigid terms of the Reclamation act itself, for under the terms of that act it is compulsory upon the Secretary of the Interior to expend at least one-half of the moneys raised from the sales of lands in any particular state upon feasible projects within that state.

Now, some of the states which contributed the largest amount to the fund were states in which there were few, if any, feasible projects.

Nevada could contribute little to the fund, while the state of Oklahoma contributed most generously, and yet in Nevada there are numerous feasible irrigation projects, and in Oklahoma there are almost none because of the topography of the country. And so a portion of Oklahoma's money has been spent in Nevada, and North Dakota's money has been spent in Nevada, but ultimately it will be returned to the fund by Nevada when its arid lands are reclaimed.

But, as I have stated, the law itself has compelled the Secretary of the Interior to use every care and diligence to find a project in the state of Oklahoma, even though it may not be so feasible as one in Nevada. And so it is in North Dakota. Inferior projects have been entered into there simply because of the generosity of the contribution of those states to this great fund. Hence the mistakes have been forced by the act itself.

I must say when the act was originally framed I was opposed to that provision which compelled the expenditure within the boundaries of a particular state of the funds coming from the sale of land in that state. I anticipated these very difficulties. I felt that so far as the reclamation of the arid region was concerned, imaginary state lines should be entirely obliterated; that it should be considered in its entirety, the moneys received from the entire area being spent upon the most feasible projects in that area, regardless of state lines.

So I would acquit the Reclamation Service of blunders in this respect, if mistakes have been made in preferring less feasible projects to more feasible projects—mistakes that were made obligatory by the very terms of the act itself.

Mr. President, I have contended that the discretion of the Secretary of the Interior has for the most part been wisely exercised. We have had one of the most capable and honest construction services organized that has ever existed in the history of this country. The Committee on Irrigation of the Senate has been engaged during the past year in visiting these various works, and not a whisper of corruption has reached them. It has been a work conducted with rare intelligence, with rare integrity, and with rare speed. Twenty-three of these projects have been almost brought to completion or are approaching completion in various sections, and now $30,000,000 is required for the purpose of utilizing the water which we have stored, to be poured upon these arid lands, thus enabling the rapid return to the fund of the moneys spent. I believe that the discretion should be as wide as it was in the original act, and I object to any terms of limitation whatever.

Train Resistance Data and the Laws of Friction.

We wonder how many of the engineering students graduating from the colleges at the present day obtain in their course a clear understanding and working knowledge of the laws of friction. We do not mean the old so-called laws given in the text-books of 25 years or more ago, based on the early and inadequate experiments of Morin and others. We mean the laws which have been developed from practical experience and the data of many investigations during the past quarter century. Certainly, if the students of to-day are well-grounded in the laws of friction, they are fortunate compared with their predecessors of an earlier generation. These men had their faith in the reliability of their school training sadly shaken when they attempted to apply their text-book theories of friction to practice.

We are led to this reflection by a study of the monograph on train resistance just issued by the American Locomotive Co. and abstracted elsewhere in this issue.

Suppose the following problem were given to a class of senior students in engineering—or for that matter to a number of designing engineers experienced in other fields than that to which the problem relates. We wonder how many would give a correct answer. The problem is: given two standard eight-wheel railway freight cars, one of 30,000 lbs. capacity, the other of 100,000 lbs. capacity. Each of the cars is carried on 33-in. wheels. What is the relative resistance to traction of the two cars, in pounds per ton, when running on a level track at speeds of 10 to 20 miles per hour?

It is to be remembered that the 100,000-lb. car has journals of between two and three inches larger diameter than the journals of the small car, so that the lever arm at which the friction acts to retard the car's motion is much greater on the large car. To put the same thing in another form: The speed of the rubbing surfaces of the large journal in contact with the bearing is much higher than the speed of the small journal, so that while the two cars each move a mile, the distance traveled by the rubbing surfaces of the journal and bearing is much greater for the larger car. It is to be remembered also that the pressure in pounds per square inch on the journal surface will probably be higher on the larger car than on the small one.

Again consider the rolling friction between the wheel and the rail. The large car when loaded has a load per wheel of nearly 9 tons. The load per wheel on the small car is probably not more than one-third as much. The heavier loaded wheel bends the rail more and deforms it more at the point of contact.

Taking all these things into consideration, would it not seem reasonable to suppose that the larger car should have the higher resistance to traction per ton of its weight? As a matter of fact and experience, however, the larger car has the smaller unit resistance; and not only is it smaller, but it is very much smaller. Expressed in figures, the resistance of a 100,000-lb. car under the conditions named runs down as low as 3 lbs. per ton, while for a car of one-third the capacity it may be as much as 6 lbs. per ton.

Now why is the friction of the larger car so much less? Evidently the coefficient of friction of the journal in its bearing and of the wheel on the rail must fall off very rapidly with increase of load. We are aware that this law of frictional resistance is by nc means new. It can be found in standard books of reference—if one consults the right ones—but the question we raise is whether engineers generally have been so inoculated with this law that it has "taken." Does the designing engineer appreciate this law enough to deliberately adopt high bearing pressures in the design of machinery in order to cut down the coefficient of friction. If not, then why not?

We seem to hear some doubts expressed when it is proposed to apply this law in actual practice so we venture to cite a second proof of its truth, taken also from experience with train resistance. Take any freight car, large or small. Draw it over a level track at a speed of say 10 miles per hour and measure its resistance in pounds per ton. Take the same car, load it to its capacity and again measure its resistance. It will be found that the resistance per ton of the loaded car is only about two-thirds the resistance of the empty car. Here is even more positive evidence that the coefficient of friction on journals is cut down very materially by increasing the unit pressure. The American Locomotive Co., in its recent bulletin on train resistance states that the coefficient of friction on car journals appears to vary inversely as the square root of the unit pressure. At this rate a bearing with a unit pressure of 50 lbs. per sq. in. would have twice as high a coefficient of friction as one loaded to 200 lbs. per square inch. At this rate it would be possible to vary the frictional resistance of a machine 100% according to whether the unit bearing loads adopted were very low or very high. Of course the limits of safe bearing loads necessary to avoid heating must be borne in mind, but modern methods of lubrication and of finishing journals and bearings have raised these limits considerably over what was deemed possible a few years ago.

The facts we have recited above may appear to some common and well-known. We believe they are, nevertheless, worth the serious study of engineers. Was there any engineer before the 100,000-lb. car was introduced who was wise enough to predict that it would have such small friction as to enable train loads to be raised 25 to 33% and to make necessary the revision of working formulas for train resistance hitherto generally accepted? We know of no such prophecy; and we believe that engineers generally will gain by a better *working* knowledge of the laws of friction.

LETTERS TO THE EDITOR.

Accurate Results Obtained with a Simple and Cheap Planimeter.

Sir: Some time ago I had made for my own use a "hatchet" planimeter as described in Engineering News, Vol. 30, p. 216, Sept. 14, 1893, except that in mine the follower part is a circular disk instead of being hatchet shaped. It is all brass and cost only 25 cts. To-day I made a few tests as to how much error there is in its use and, thinking the results may be of some interest to some of your readers, I give them below. The length of the planimeter is 14.1 ins. from tracing point to point of contact of the disk with the paper. I tried measuring the area of two circles, choosing that figure since there is no uncertainty as to the position of its center of gravity and because it is easy to get the area by measuring the diameter and taking the area from a table of areas of circles.

The first circle (taken at random) that I tried was 6.86 ins. in diameter; true area 37.0 sq. ins. It was drawn in such a position on the paper that when its perimeter was traced the disk happened to go off the

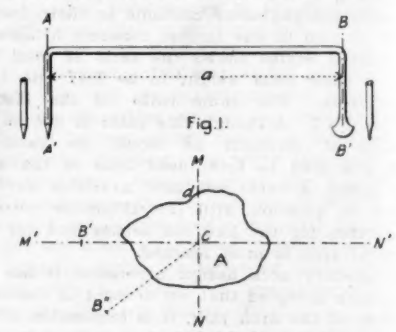

Fig.2.

Sketch Showing a Simple Form of Planimeter and Method of Using It.

paper and onto a rather rough drawing board, the result being that the area was not measured closely, the area being found to be, by first trial, 40.2 sq. ins.; second trial, 32.1 sq. ins. The errors are 8% and 13%, respectively. I then drew circles located so that the planimeter would not get off the drawing paper in tracing their perimeter and get the following results:

Diameter of circle, 6.86 ins.; true area, 37.0 sq. ins.

	Error, sq. ins.	Per cent. of error.
Area by planimeter, tracing clockwise, 35.2 sq. ins.	1.8	5.0
Area by planimeter, tracing counter clockwise, 37.5 sq. ins.	0.5	1.2

I then tried another circle of larger diameter with the following results:

Diameter of circle 9.38 ins.; true area, 69.1 sq. ins.

	Error, sq. in.	Per cent. of error.
Area by planimeter tracing point, moving clockwise, 69 sq. ins.	0.1	0.3
Area by planimeter tracing point, moving counter clockwise, 69.7 sq. ins.	0.6	0.9

Average error: small circle, 3.1%; large circle, 0.6%.

I made no other trials. These results seem good to me for so cheap an instrument, but deductions drawn from such a small number of trials may be valueless. What error will usually attend its use this does not show.

"C. E."

Nashville, Tenn., Feb. 11, 1910.

[We reprint below from a letter published originally in our issue of Sept. 14, 1893, the description of the planimeter referred to in "C. E.'s" letter.—Ed.]

. . . Make of a piece of steel wire a hook, as shown in the sketch, Fig. 1. End A' is made to a point, while end B' is flattened at the sides and has a curved edge in the direction A B. With this simple tool, a given area can be measured in the following way:

Mark out the center of gravity C, Fig. 2, of the area A to be measured. If it is not otherwise known, mark

this center C by eyesight. Through C draw two lines, M N and M'N', Fig. 2, at right angles to each other. Place point A' of the hook (Fig. 1) on this center C, and point B' of the hook on, say, line M'N'. By pressing on end B of the instrument make a mark, B' (Fig. 2), on the drawing. Move end A of the hook from C to the intersection point d, between the line M N and the outline of area A. Move point A further from d all around the outline of area A and back to d, and still further back to the starting point C. During the whole operation end B of the instrument must be allowed to travel its own way undisturbed; that is, point A' of the instrument will revolve around the varying position occupied by point B, Fig. 1, and B will always move in the changeable direction, A B, without sliding sideways. (It probably will slide sideways somewhat, but in an oblique direction, unless point B' is made adjustable, as described below.—Ed.) Hence, by the time end A has arrived at its starting point, C, end B will have assumed a position B'' (Fig. 2). Measure the distance B'B'' (Fig. 2) and multiply it by the distance A B (= A Fig. 1). This gives a product equal to the area A, provided end B of the hook during its operation never comes inside the area A.

This method is not strictly correct, theoretically, but approximate enough for most purposes.

If made for permanent use this instrument can be modified in a number of ways. Probably it would be best to make ends A and B separate, so as to be affixed conveniently to any scale beam or rule. It might also be of advantage to make end A so as to permit end B and the beam A B to revolve around the axis A A' (Fig. 1), thus insuring an entirely free and independent motion of end B. Also, if deemed convenient, end B instead of a curved edge, as shown, might have a wheel of suitable diameter and shape, and so on.

Eric Swensson.

Watseka, Ill., Aug. 3, 1893.

[An improved form of hatchet planimeter, having a pair of wheels and a pencil in place of the blade, was described by Mr. A. L. Menzin in Eng. News Aug. 9, 1906, p. 131. The theory of the instrument was also set forth by him. The original inventor of the hatchet, Lieut.-Col. H. Prytz, of Copenhagen, gave the theory and a statement as to accuracy, in Eng. News, April 4, 1907, p. 387.—Ed.]

The Undermining of a Reinforced Concrete Retaining Wall, Dayton Ohio.

Sir: The accompanying half-tone (Fig. 1) is a picture of the southwest wing-wall of the Washington St. Bridge in Dayton, Ohio, which was undermined on Feb. 20, 1910. The wall was a reinforced-concrete structure of the cantilever type, a section of which is shown in Fig. 2. There was absolutely no fault with the wall as a retaining wall, it having always fulfilled its purpose in that respect, as the part of the wall still standing adjacent to the bridge, shown on the right of the photograph, attests. The failure of the wall was due to the breaking of a dam, a temporary structure which adjoined the wall at the break to the left, where the waters can be seen swirling in the picture. The constant wash below the dam, which had no apron, prepared the way for the final catastrophe. This occurred when the river was at a comparatively low stage, not high

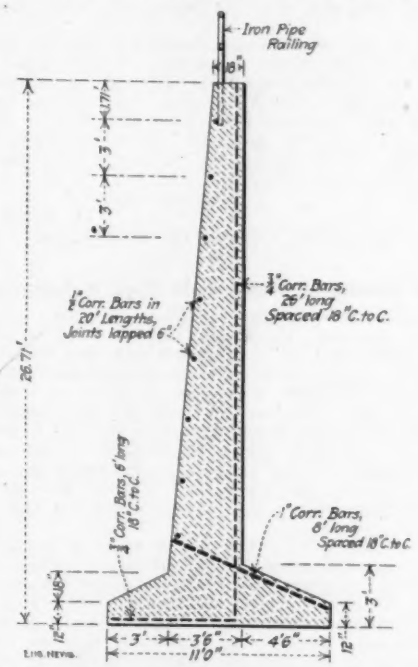

Fig. 2. Section Through the Dayton, O., Retaining Wall.

enough to destroy the dam, but just high enough to cause a maximum wash.

The undermining occurred at a point directly at the base of the dam, causing the wall to sink at that point. The wall was built in sections, with expansion joints, and one of these sections has toppled over, leaving the open space shown on the photograph to the left. This space is much larger than appears in the perspective of the picture, being about 16 ft.

Fortunately for the levee the wall settled, downstream end outward, in such a position as to deflect the current in the river and prevent further erosion of the bank. The settled portions of the wall have been grappled with hooks and anchored to the shore, so as to maintain them in their present position where they protect the levee.

The dam itself was originally built merely as an experiment, to see what effect the rise of the water would have on adjacent property in the city, should a permanent structure be erected at that point. It was framed on the piles driven for a temporary bridge which crossed the river during the construction of the Wasaington St. concrete arch bridge in 1906. The original dam has repeatedly broken, and has been replaced by a crib structure as fast as it has washed out. The fall over the dam was about 5 ft. Shortly after it was originally completed, it broke on the side of the river, opposite to the present accident, and undermined a riprap wall which protected that bank. When that side of the river was repaired, stone and boulders were piled up at that end of the dam to prevent a similar occurrence. Such precaution was not taken at the other end of the dam, chiefly for lack of funds, the dam being built by private enterprise.

Contractors and engineers of the old school are trying to use the failure of this wall as an argument against the use of reinforced concrete in retaining walls, but the almost perfect condition of the wall as it stands, even after settlement, is sufficient argument against them. The wall was a fairly high one and the material behind it was of the loose, tin-can dump variety, containing practically no packing material, so the conditions were such as to make a good test for a wall of its design. Its action under the present trying conditions is a vindication of reinforced concrete; in fact, had there been no expansion joints provided, the wall would probably still be standing, by virtue of its longitudinal reinforcement, in a kind of continuous beam action.

Yours very truly,

Harry F. Finke, Ass't Engineer.

Office of the City Engineer, Dayton, O., March 2, 1910.

FIG. 1.- REINFORCED-CONCRETE WING WALL TO WASHINGTON ST. ARCH BRIDGE, DAYTON, O., UNDERMINED BY OVERFLOW WASH FROM AN ADJACENT TEMPORARY DAM.

High Duty Records of Pumping Engines.

Sir: Referring to your article on pumping engine duties in your issue of Feb. 3, 1910, I will say that you did not give the highest duties thus far attained. You will readily agree that the character of the material pumped has nothing to do with the economy of the steam engine; whether the substance pumped is gas, air or oil is immaterial in the comparison of economy between different steam engines. The basis of comparison is the 1,000,000 B. T. U. or the 1,000 lbs. of steam delivered to the engine. On this basis, Bruno Nordberg, of Milwaukee, Wis., has all the other manufacturers swamped. His record engine so far is one of four large air compressors at the Champion Mine, Painesdale, Mich. This compressor was tested by Prof. O. P. Hood, of the Houghton, Mich., School of Mines; it was tested in service under every-day working conditions. The engines were guaranteed for 180,000,000 ft.-lbs. and under test developed 194,930,000 ft.-lbs. (see Proc. Am. Soc. M. E., Vol. 28, Dec., 1906, p. 221).

I believe that ever since 1898 Nordberg has had the record for pumping engines. The engine I refer to is one of two quadruple-expansion engines built for the Pennsylvania Water Co., at Wildwood, Pa. (Eng. News, May 4, 1899). These engines were tested by Prof. R. H. Thurston and the duty developed was 162,948,824 ft.-lbs. per million B. T. U. (see Trans. Am. Soc. C. E., Dec., '99). This duty has been surpassed since, but now again Nordberg is above the rest head and shoulders.

The Nordberg Mfg. Co. are now erecting at Morenci, Ariz., two four-cylinder, triple-expansion poppet-valve pumping engines. The test will be made shortly. The company expects that these engines will break the few existing records.

Referring again to Prof. Wood's paper you will see (p. 237) that the heat units per min. per I. HP. are only 169.29 B. T. U. It is not Nordberg's fault if pumping engine duties are not higher, it is only a question of more money. There are only but few places in this country where it pays to pay a very high price for an engine of very high efficiency. If you pay him his price, Nordberg I am confident, will build you a 250,000,000 ft.-lbs. engine to-morrow. To my mind the improvement in duty is not so much a betterment in mechanical excellence as a better understanding of the commercial value of high efficiency.

Yours very cordially,

H. F. Labelle.

Silver City, N. Mex., Feb. 8, 1910.

Sir: In Engineering News for Feb. 3, 1910, there appeared an article under the title "Recent Records of High-Duty Water-Works Pumping Engines." This described two engines in the North Point pumping station at Milwaukee and the new high lift station at Albany.

There is one statement in the article which might lead to a misunderstanding and which you will undoubtedly be glad to correct. Reference is made to "The two latest engines in the North Point pumping station," and the description and test results of two pumping engines manufactured by the Wisconsin Engine Co. are given.

Since these engines were built, the city of Milwaukee has awarded contracts for two 12,000,000-gal. pumping engines at this station to the Allis-Chalmers Co., of Milwaukee. One of these engines has been completed, tested, and put in regular service. The second is now

inder construction. Accompanying this is a brief description of the pumping engine and a summary of the test of the engine that is already completed.

It may be of interest to you to know that the first pumping engine in this country to attain a duty of 154,000,000 ft.-lbs. per 1,000 lbs. of steam, and installed by the Allis-Chalmers Co. in the North Point pumping station (Milwaukee) in 1892, recently had the cylinder head removed for the first time since it was started. No wear was apparent and the head was replaced without any attempt at adjustment or change.

Another high-duty pumping engine which has but recently been completed and tested is that erected by the same company for the city of Nashville, Tenn. A brief description of this installation, together with a summary of the test is enclosed.

Trusting that the accompanying information may be of service to you and hoping that Engineering News will have continued success as the leading technical engineering magazine, we beg to remain,

Most sincerely yours,
Allis-Chalmers Co.,
Will J. Sando,
Mgr. Pumping Engine Department.

Milwaukee, Wis., Feb. 16, 1910.

[We publish elsewhere the particulars of the engines and tests mentioned by Mr. Sando.—Ed.]

Sir: Referring to the editorial note in your issue of Feb. 3, concerning the economy of pumping engines, it should be noted that while the increase of duty of the Albany engine of 1909 (triple-expansion) is 38,000,000 ft.-lbs. greater than that of the Pawtucket engine of 1879 (compound), yet the duty of triple-expansion engines has scarcely increased at all in the last ten years. The Albany engine, according to your editorial, gave 1 HP. with 193 B. T. U. per minute. The Chestnut Hill (Boston) engine in 1900 gave 1 HP. with 196.08 B. T. U. per min., and the Wildwood, Pa., engine 1 HP. with 185.96 B. T. U. per min. (Eng. News, Sept. 27, 1900.)

The high duty of the Wildwood engine is accounted for by the heating of the feed water in separate stages, by steam drawn from the several jackets. It would be interesting to learn what was the reason the Albany engine gave a higher duty than the Chestnut Hill, although the latter had the advantage of higher steam pressure (187.4 lbs. as compared with 168.2 lbs.). Was it due to a greater range of expansion, less clearance, better jacketing, or what?

Wm. Kent.

Montclair, N. J., Feb. 4, 1910.

We submitted the above enquiry to the Holly Mfg. Co., but the reply failed to give the information requested, and a request for more specific information has not been complied with. The company's statement is as follows:

The principal features of the [Albany] engines which account for the especially high duty are of course refinement of design and construction.

The Distortion of Steel Penstocks.

Sir: When I noticed the article on steel penstocks in the issue of Engineering News for Feb. 10, I was pleased by the prospect of securing information on one point which has given me much trouble. Unfortunately Mr. Wright failed, by accident or design, to take up the particular point. Now, large horizontal pipes made of thin plate are very flimsy and it becomes necessary to add stiffening hoops at intervals to prevent their flattening out when empty or when partly filled with water. Just how to determine the proper size, location and number of these stiffeners is the point that Mr. Wright fails to take up. When a penstock is just full of water there is a strong tendency toward flattening, especially in large diameters.

I should be glad to know how he cares for this element in his designs. Yours truly,

O. M. Davis.

1009 Chicago Savings Bank Bldg., Chicago, Ill., Feb. 14, 1910.

[The following reply to Mr. Davis by the author of the article in question may prove of interest to our readers generally.—Ed.]

Sir: Replying to Mr. Davis' letter, I would say that the conditions mentioned are of such rare occurrence that it seemed hardly worth while for me to take it up in my article, especially as a thorough analysis would require no small space. Cases have occurred, of course, where it was found necessary to add stiffening rings to hold the penstock to a circular shape while empty, notably the 18-ft. (diameter) penstock of the Ontario Power Co., Niagara Falls, but it should never be necessary to consider the weight of the water inside as mentioned by your correspondent, since this should be taken care of by properly supporting the lower half of the penstock rather than by the use of stiffening rings on the top.

The tendency to bulge at the sides can, of course, be figured by the usual methods for two-hinged arches, making the proper assumptions in accordance with conditions. The worst case would be where the penstock is resting on a flat surface—the upper half then would be a semicircular arch uniformly loaded and the lower half would have to carry the upper half in addition to its own weight. The total horizontal thrust would have to be taken care of by the rings riveted to the upper half.

In the light of the present knowledge of reinforced concrete I would consider it generally advisable to use a concrete penstock under such conditions. In the case mentioned above, that of the Ontario Power Co., the penstock after completion was covered with 15 to 18 ins. of concrete and it seems certain that the construction of a reinforced concrete penstock in the first place would have been more economical.

Very truly yours,
R. A. Wright.

7 South Sixth St., Pottsville, Pa., Feb. 20, 1910.

The Amount of Water to be Used in Concrete.

Sir: In the engineering profession, a few years back, *beton agglomere*, the French term for what is now universally known as concrete, was made with the least amount of water that would produce a damp mass, which mass when rammed, would show on its surface a thin film of water. The books all taught that the amount of water should never exceed the amount necessary to produce a mixture something like that of our old-time brown sugar. To-day engineers are running to the opposite extreme, and now concrete is almost universally made sloppy; that is, it is of such consistency, that it cannot be rammed.

Concrete may be injured by too much or too little water, and this arises from the difficulty of getting, at all times, the proper proportion of water that will enable it to be rammed without disintegration. If it be too dry, it will not consolidate, if it be too wet it cannot be rammed. Engineers are content to have concrete made by the most common laborers, sometimes by foreigners who cannot understand our language, and could not comprehend the importance of the instructions of the overseer if they understood his words.

The quantity of water required for a cubic yard of concrete will often vary considerably during the day. If the sand and stone are warm and dry, more water will be required than when they are cool and moist. The sand and stone from the interior of the pile will generally require less water than from the outside. This is particularly the case in warm and dry weather.

The writer in making concrete for the batteries at Portland Head has seen the quantity of water vary as much as from 10% to 20% during the course of a summer day. Less was required in the morning and evening than in the middle of the day. It may be said that concrete is more apt to be injured by being too dry than by being too wet. However, there is a tendency to run to the latter extreme. To reach a happy medium, is the object to be sought. It is not safe to determine the amount of water by rule and adhere to it all day long. The overseer should be a man of sense and should give personal attention to the concrete turned out by his men or machines, and change the amount of water as often as necessary. Reinforced concrete cannot always be rammed, indeed it is only in rare cases that it can be. The deficiency in strength in those cases can generally be supplied by increasing the quantity of cement, but even that will not always compensate.

The writer has, in laboratory experiments, seen a good Portland cement reduced 50% in tensile strength, when the amount of water used was not in excess of what *appeared* to be necessary to give such plasticity to the mortar as would enable it to be pressed into the molds.

The object of the foregoing remarks, is to call attention to what is believed to be a tendency on the part of engineers to use more water in their concrete than is necessary.

Peter C. Hains, M. Am. Soc. C. E.

Union Trust Bldg., Washington, D. C., Feb. 25, 1910.

Bonding Plaster Coatings to Concrete Interior Walls and Ceilings.

Sir: In your issue of March 3, 1910, p. 256, you print a letter from Mr. Fred H. Hall, Moscow, Idaho, in which he states that he, along with many others, has had some difficulty with interior plastering where it is applied directly against concrete.

In your note following Mr. Hall's letter you state that ordinarily interior concrete walls and ceilings are not covered with lime plaster. In this you are wrong. I visit jobs every day—many of them in fact—where both "lime and hair" mortar and "patent plaster" are applied directly against concrete ceilings.

Many of these ceilings are of course cinder concrete which, because of its more or less porous nature, makes a first-class key for plastering. I have also seen many jobs where concrete with broken stone aggregates has been employed for floor arches. There has been, with but one exception, no difficulty in plastering against such a surface, principally, because rough boards have been used for forms, the impression from which makes a good key. The exception I speak of is the Monolith Building on 34th St., near Broadway, New York. On this job the surface of the concrete was so smooth that it was necessary to go over it with a compressed air tool in order to make a key to hold the plaster.

Very truly yours,
H. A. Brocas, Manager New York Office,
The Kelley Island Lime & Transport Co.

1133 Broadway, New York, March 4, 1910.

Notes and Queries.

J. F. B., Harrisburg, Pa., writes:

Do any of your readers know of the "Dewey" decimal system being used in a mechanical drawing room where 15,000 or more drawings have to be filed and indexed? What advantages has the system over the continuous numbering system? How are the various sizes of drawings and the pattern numbers taken care of?

FRICTION IN THE DELIVERY PIPE LINES FROM A HYDRAULIC DREDGE.—In the note on page 261 of our last issue describing the progress in filling the Gatun dam at Panama it was stated that the friction in the pipe lines from the dredges was 2 to 2½ ft. per 100 ft. of pipe. A correspondent of much experience in hydraulic dredging questions this figure and states that in ordinary hydraulic dredging work a friction loss of 2 to 3 ft. per 1,000 ft. is an average figure. It may be thought that a cipher had been accidentally omitted from the item in the "Canal Record" which we copied. From the tenor of the item, however, we judge that the friction must be as high as stated or the installation of the relay pumps would not be necessary.

In the article "Changing an Interurban Electric Railway from Alternating to Direct-Current Operation" in our issue of March 3, it is stated that the Baltimore substation of the Washington, Baltimore & Annapolis Electric Ry. supplies current at 600 volts to the overhead lines in Baltimore up to the junction with the tracks of the United Railways Co., in that city. The voltage actually imposed is 1,200, the same as used on the main line of the interurban road. The right to increase the line voltage from 600 to 1,200 in Baltimore was obtained only a few months ago. The actual weight of the older single-phase cars, used before this change in operating system and as finally equipped but without passengers, was 59 tons instead of 54.5 tons as stated in the article mentioned and in the earlier article on the old system. (Engineering News, 1908, Jan.-June, p. 195.)

The Necessary Elements for Water-Works Valuation.*

By JOHN W. ALVORD,† M. Am. Soc. C. E.

The work of valuing the property and plant of public utility corporations in this country is coming, increasingly, to be of importance since the realization on the part of capitalists and the public that the courts are more and more interpreting the relations of the public-utility company and the public as a quasi-partnership. It is now a well-established rule that moneys devoted to the use of the public in furnishing water, gas, electric light, telephone service and transportation are to be differently treated from capital devoted to a private enterprise under free and unrestricted competition. It has been repeatedly pointed out by the courts, for instance, that the rates to public utility corporations must constitute a fair return upon the capital properly and usefully invested for the purpose of serving the public, if, at the same time, their decisions confirm to the municipality or the state the right to regulate such rates, as they do. It is obvious that it is intended and expected that inordinate profits in this field of activity are not to be permitted on the one hand, and as a corollary to this conclusion, it is necessary that moneys devoted by investors to public purposes cannot be subjected to unreasonable losses.

One of the most fruitful causes of confusion in considering the valuation of public utilities lies in the fact that most people fail to distinguish between properties serving the public exclusively under a franchise granting special privileges, in which there can be no real competition, and a manufacturing plant that has no such privileges, and that supplies the needs of the people in some line where private competition has free play, and in which the use of the public property, such as streets and highways, does not enter. Light on this distinction is had by studies of the reasoning of such courts as have made examination into the valuation of public utilities for the past dozen years or so. This study has resulted in the preliminary confirmation of methods and practice for the determination of the valuation of such properties, whether for the purchase of the plant by the city or predication of fair return upon capital invested.

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There are at least three and perhaps four methods of valuing a public utility property such as a water plant, all of which the courts have held are proper under certain circumstances:

(1) The method of reproducing the property and business at present cost, lessened by any depreciation which the original plant or business has suffered.

(2) The method of ascertaining the actual past investment from the books of account, in which case neither depreciation or appreciation are usually considered.

(3) The method of determining the value by the market price of stocks and bonds when it is certain that an active and representative market can fairly be said to exist.

(4) The method of valuing from the standpoint of a willing seller to a willing buyer, who, as a judicious investor, judges the plant by a careful analysis of its income, privileges, duties, and the future prospects of the city it serves, all without going greatly into cumbersome detail.

The first method has been the one which the courts and appraisers have most commonly used, and proceeds on the theory of an imaginary duplication of the property at prevailing prices for materials and labor. This method necessarily involves, as a mental process, a re-creation, step by step, of what may be termed a "conceptual starting plant," that being gradually built up as a mental picture by the aid of experience, local information, and trained imagination, will, as a process of mind, eventually duplicate in its final form and detail the existing or going plant.

It will be obvious from this definition that, while this method at first glance apparently has the charm of simplicity, it is to be doubted if this seeming simplicity really exists in practice. The method logically requires many refinements, some of which are quite complex.

The second method of valuation of a property before mentioned—that of past cost—is often impossible of fulfillment by reason of lack of carefully kept accounts from the beginning of the enterprise. Where these exist, and where it is known that they have been carefully kept, they form an adequate basis upon which to predicate values, for it is obvious that nothing can be more fair, either in the fixing of rates or the transfer of a property, than consideration of the actual cash investment in that property from the beginning of its history, especially when it is known that it has been honestly and wisely made. Few companies, however, are able to produce such data. Changes in ownership, carelessness in accounting, and other uncertainties, usually render it impossible to give a connected financial history of the plant, however desirable it might be to do so.

The third method of determining values before mentioned—that of proceeding upon the market price of stocks and bonds when an active and representative market can fairly and certainly be said to exist—is one which is obviously rarely possible in the consideration of public utilities. For water-works securities, at least, active and representative markets have not existed for many years. This class of securities has been largely in disfavor with the general investing public, due to the over-sanguine prospectuses of the original promoters, the disappointments in realization of reasonable profits, often to the hostility of the public, and the entire neglect on the part of the investor, or promoter, to realize the importance and significance of depreciation, or to provide therefor in any way. I do not know in recent years of any case where there could be said to have existed a fair market value of the stocks and bonds of a private water-works company which gave any reasonable indication of the value of the property. The fact of the matter is that the owners and investors themselves usually have little idea as to what is the true value of the investment which they are handling, except perhaps in a general way upon a basis of past cost or available net revenues.

This brings us to the fourth method which I have mentioned, which, while valuable in all ordinary business intercourse for the purchase of competitive properties, does not afford that satisfactory and definite conclusion when dealing with public utilities which is desirable, for the reason that with the regulation of rates by the municipality or state there is afforded the company no opportunity to make good in the future the deficiencies or misfortunes of the past. This fourth method, however, in some cases is a desirable method to investigate, in connection with the first method as a sort of a review or check, for it sometimes gives us an insight into the question of rates in a way that is illuminating and convincing.

Having, therefore, outlined briefly these four methods of valuing properties of this character, and knowing that probably nine-tenths of the time, either through the influence of the courts, the owners or the public, we are obliged to fall back upon the method of valuation by reproduction, it may be desirable to note the necessary elements to be considered in the method of reproduction. First and foremost, it is obviously necessary to prepare a statement of the physical property in such manner that the estimator can re-create it in his imagination in a practical and humanly possible manner. Such a statement is usually called an inventory, a name which is rather of a misnomer, for a proper statement of this kind, far from being an inventory of the character that such a name would usually imply, is much more. Inventories (so-called) are generally lists of physical property, such as tools or stock and no more, but the inventory of which we here speak is in the nature of a general plan and specification, and yet even more than this, for it is a definition of all of the known facts with reference to a property, its history, the difficulties which it has surmounted, the structures which have had to be temporarily erected and destroyed in order to bring it to its completed shape. All these things must be fully outlined in such a way that the estimator can retrace as an unfolded panorama in his mind, step by step, each stage in the progress of the plant and its progress from the original concept in the mind of the projector, through the preliminary production of plans, the expenditure of capital for promotion, the time necessary for construction, the orderly introduction into his outline of each structure in the place and time when it would naturally be begun and finished, up to the final completion and placing into operation of the finished works and obtaining the necessary business or income therefor.

Such a statement, while called an inventory, is obviously a specialized compilation of the most important character, and should be best prepared by those familiar with its purpose and intent. Once prepared, it becomes extremely valuable to a company because of the large amount of information which it will afford both as to the present condition, general arrangement, and detailed dimensions of all underground construction, as well as its past history including the difficulties under which the structure was put into shape for useful service. It desirably includes photographs not only of present construction but also of past or original construction; tables showing growth, with particular attention to the age and general condition of each part; plates showing the character of the soil, and the special difficulties of construction in the locality; tabulated statements of account, variety, weights, quantities, or other units to be computed upon; brief history of the original difficulties such as treacherous foundations, wet soils, and other unusual conditions; full mention of all structures and plant appliances, which were necessarily in the original construction but which may have disappeared when their useful purpose was ended; brief account of the structures or machines which have depreciated by changing conditions and the reasons therefor; also special information tending to show the possible future life of the different parts or structures, and any information that will throw light upon the appreciation or depreciation of the property by reason of the fact that its present reproduction will be more or less costly than the original reproduction would have been. These are only hints as to the variety of information which is to be contained in a statement of this kind as against what is commonly designated as an inventory merely.

With such an inventory or statement in hand, it is next desirable to engage an estimator who has the following requirements:

(1) Broad experience in the construction or observation of water-works of all classes in various localities, large or small; also experience in the operation of water-works properties.

(2) It is desirable that an estimator should have what is known as *the proper frame of mind*; that is to say, experience with all of the various points of view which are thrust sometimes so unceremoniously upon men charged with this kind of responsibility. He should desirably have served cities as well as water companies, if not in equal number, at least sufficiently often on opposite sides so that he can appreciate all points of view that come with the problem. Without this experience he can hardly hope to be able to preserve that balance and equanimity of mind which is so necessary to fairness.

(3) He should possess a considerable and vivid imagination, trained though it may have been into practical channels by reason of long experience. The great temptation of the inexperienced estimator in reproducing plants and properties is to "short-cut"; that is to say, having before him the completed works, and efficient hind-sight only as to the apparent ease with which it was put into place, he is obviously tempted to rub a sort of an "Aladdin's lamp" in his mind, and lo the works are completed at not only a very minimum of cost, but sometimes an impossibly low figure. The frame of mind which an estimator should have when he attacks the problem is that he, himself, is charged with the responsibility of completing a works like this, and that his reputation is at stake in making a preliminary budget which shall fairly and accurately cover the cost of the plant, with all its contingencies in the future. No other frame of mind than this will produce honest, satisfactory or just results.

Appraisal boards charged with the duty of determining the value of plants, either for rate-making or sale, are customarily composed in a bi-partisan manner; that is to say, franchises usually provide that the city shall choose one member, the company another, and they two, in turn, choose the third member of the board. There is probably no more vicious and improper method of selecting appraisers that could be devised. The very attitude of mind which is induced by such an arrangement is that of a partisan on the part of at least two of the members of such a board. Only trained and experienced men of considerable character can successfully overcome the unfortunate temptation of such a position and throw off from themselves the idea that they are there to represent a client. Where this method of selection is pursued, the estimator falls easily and naturally into the vicious attitude of looking at the problem from a one-sided standpoint in the unhappy desire of better serving those who appointed him. The result often is that the two estimators appointed as representatives generally fall apart little by little, and, as the work proceeds, the breach grows wider. Meanwhile the third appraiser, or the umpire as he unfortunately becomes, is obliged to settle differences between them, or to harmonize them in a manner that satisfies neither the problem nor the remainder of the board and eventually he becomes himself a sort of sole appraiser upon whom the responsibility devolves, under the most unfortunate and uncomfortable circumstances, of settling the final value. By the time the valuation is completed feeling often reaches such a point that no calm, dispassionate review of the whole valuation is possible, and the appraisers part with the feeling that they never want to enter into another appraisement of the same character.

Now this whole attitude would be easily changed if franchises could only contain a clause that such boards are to be selected and appointed in such a way that *no one member* of them *shall be considered, or shall be the representative of the interests either of the city or of the company.* This can be accomplished in a number of ways, either by representatives of the city and the company meeting and canvassing the names proposed, or appointing representatives to do so in such a manner that the appraisers selected are entirely unaware and even indifferent as to whose influence placed upon them their responsibilities. When properly appointed in this way, such a board produces harmonious study, disinterested discussion of each mooted point, and the results are reached in less time without friction and with greater fairness. A dispassionate review of the whole work upon its completion is possible, and the entire energies of the board are concentrated upon the real subject in hand rather than upon the unhappy necessity of watching to see that individually they are not perhaps influenced by some bias originating usually in the minds of the clients or their attorneys whose interests are at stake. Engineers are not naturally partisans. Their profession tends to develop the open mind, and it is unfortunate to find them ever obliged to accept positions of partisanship, for they are not naturally adept at the practical.

A carefully prepared inventory and statement of a water-works property (whether municipally or privately owned) and a valuation thereon is of great service in many ways. In the ordinary conduct of such a property, it is essential to have the officers and employees of the plant have a complete knowledge of the works under their charge, as well as its past history and present condition. Such knowledge affords a starting point for improvements, changes, or alterations, which are so continually necessary in any growing water-works serving a prosperous city. The value of a plant and property is sometimes a surprise to the owners, and almost always an unknown quantity to any municipality. It affords a basis for bonding (where privately owned) or for writing off properly and equitably depreciation, either when publicly or privately owned. Carried forward from year to year by correctly audited additions to the capital account, it becomes unnecessary to make further valuations in the near future, as such values become increasingly useful as a basis for sale, for computing fair return, or for observing the ordinary operation of the plant, or various rating matters. Private companies everywhere are appreciating these conditions; municipalities in general have not yet fully awakened to them. It is believed that in a few years no well-conducted private company will be without its complete inventory and valuation, and that municipalities will, before that time, begin to wake up to the fact that they, too, have no knowledge as to the real value of the property which they are operating, the proper amount to write off for its depreciation, or any scientific basis upon which to predicate their rates.

RAILWAY TRAINS IN CANADA are limited, by what is known as the Lancaster Law, to a speed of ten miles an hour over grade crossings in towns or villages, or grade crossings where any accident has occurred during the previous year. The law is objected to by the railway companies on the ground that during night hours, when city streets are deserted, a considerably higher speed than ten miles an hour may be run without danger in passing through towns of moderate size. The law also compels slow-downs for a year at country grade crossings where an accident has occurred, even though the accident may have been entirely due to the negligence of the traveler on the highway.

A New Subway Line for New York City; Its History.

As noted in our last issue, New York City will soon begin the construction of an extensive new rapid-transit subway system. This much-needed forward step must be credited to the following two causes: First, the new city administration which came into office at the beginning of the current year is actively interested in bettering transit facilities, whereas during the preceding administration little or nothing was done and at times even obstructive tactics were used. Second, the Courts decided, a few months ago, that the city has still a sufficient margin of borrowing power for a large expenditure on new subways. The city officials believe that, with economical management of city affairs, they can afford to appropriate 20 to 25 millions of dollars per year for five or six years to come, the period required for completing the work.

ROUTE.—The route of the new subway was described in our last issue, and is shown on the map herewith. It comprises a main trunk north and south through Manhattan borough on Lexington Ave. and Irving Place from the Harlem River to Tenth St. and on Broadway, Vesey and Church Sts. from Tenth St. to the Battery; two branches in Bronx borough, one northeast via 138th St., Southern Boulevard and Westchester Ave. to Pelham Bay Park, the other northerly via River Ave. and Jerome Ave. to Woodlawn Road, connecting with the Manhattan trunk by a tunnel under the Harlem River; a Manhattan-Brooklyn line extending from the North River via Canal St. across the East River on the Manhattan Bridge to connect with the Fourth Avenue Subway in Brooklyn now being built, which thus becomes an integral part of the larger system; two branches southerly from the Fourth Ave. line extending south to Fort Hamilton and southeast to Coney Island; and a loop feeder line in Brooklyn through Lafayette Ave. and Broadway, connecting with the Fourth Ave. line at one end, and at the other crossing the Williamsburgh Bridge and entering the Center Street Loop subway in Manhattan, which is thus also incorporated in the system.

PRECEDING SUBWAYS IN NEW YORK.—This is the first important subway enterprise undertaken by New York City since the first (Elm Street) subway was begun, a little over ten years ago. The Brooklyn Extension of the Elm St. subway via the Battery Tunnels was really a part of the original plan, merely delayed a few years for convenience. On the other hand, the two short sections of subway since built, the Center Street Loop and the Fourth Avenue (Brooklyn) subway, were undertaken because they would be central strategic elements of future subway systems and would give the city a great tactical advantage in any future contingency of legislation or financing where the city might come into opposition to private franchise-seeking interests.

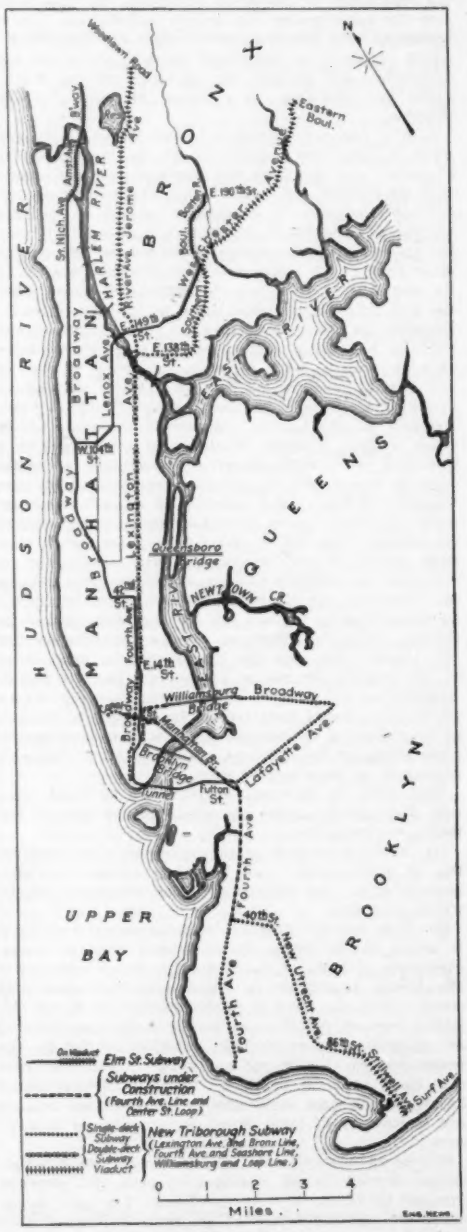
The history of the new project is quite involved. While much briefer and less complex than the history of the first subway line (detailed in our issues of Jan. 30 and Feb. 6, 1902), it is sufficiently interesting to be worth recording here, and it exhibits strikingly the vicissitudes and delays that may beset important municipal undertakings.

History of Triborough Line.

PLANNING A SUBWAY NETWORK.—The Rapid Transit Commission, after completing the Elm Street subway in 1904, began work in 1905 and 1906 on the task of laying out many new subway routes, enough for the needs of 30 or 50 years to come. Taking a map of the city, they drew in a subway route on nearly every available street in Manhattan, and the main thoroughfares of Bronx and Brooklyn boroughs. Most of these lines were well chosen. In our issue of Dec. 27, 1906, p. 681, will be found a map showing about half of the projected routes.

At that time the public had become enthusiastic over the success of the Elm Street subway, and clamored for further subway construction. The Elm Street subway before its construction had found little favor with capitalists, and bidders for building and operating it had been very scarce. In 1905 the state of affairs was different, and several offers to bid on new routes were made. There were good prospects for early construction, and the Board of Estimate therefore selected seven of the projected routes as the ones to be taken up first.

LEXINGTON AVE. LINE.—The most popular lines among the new projects were two: the Broadway-Lexington Avenue route in Manhattan extending north to south via Lexington Ave., 42d St. and Broadway; and the Fourth Avenue route in Brooklyn, composed of several of the sections of routes laid out by the Commission,



Map of New York City, Showing Route of New Triborough Subway.

which would extend from Manhattan by way of one of the East River bridges into Brooklyn, with possible extension to Coney Island and possible later connection by tunnel under the Narrows to Staten Island.

NO BIDS.—Prompt action was taken to forward the larger one of these two projects, namely, the Lexington Avenue route. By the end of 1906 the plans for this route were ready for bids. But in April, 1907, when bids were to be opened, no bids had been received.

This surprising result was due in part to unfavorable legislation and in part to financial intrigues.

(1) The State law under which the original subway contract had been let was changed while the new projects were under consideration; many more rigid provisions to protect the public interest were established, franchises for operation were limited to 20 years, etc. The result was that the eagerness of capital to seek profitable subway operating leases was at once diminished nearly to the zero point. This would have been of minor importance except for the fact that the city's remaining borrowing capacity (within the legal limit of 10% of the assessed valuation) was very low. Years of riotous living by the city government had piled up the bonded indebtedness to a point where the city would have to look to private capital for the large sums needed to build a new subway. By the time the law was again changed and made less restrictive, other obstacles had intervened to hold up subway construction.

(2) While for a short time there was rivalry between different sets of capitalists to gain control of new subway routes, this was killed by consolidation of interests. The Interborough Rapid Transit Co., which had the operating franchise of the subway and also leased the Manhattan elevated railways, was opposed by the surface-railway interests, the capitalists who controlled the Metropolitan Street Railway combine, and the latter publicly offered to bid on a subway route as soon as a route should be let for bidding. But before this event could occur, the rival interests combined in the formation of the Interborough-Metropolitan merger, and the threatened competition was put to sleep.

Combined with the latter factor was the opposition of the Interborough company to the route selected by the Rapid Transit Commission. The company wanted to extend the subway system by building such east side and west side sections as would, with the Elm St. subway, enable it to establish two complete and independent lines, one on each side of Manhattan. The company was the more firm in this attitude because of the new law, which rendered the enterprise less attractive as an investment; the result was that the company refused to bid.

The Lexington Ave. route remained dead from that time until recent months.

CONTRACTS FOR FOURTH AVE. LINE.—For a time the city authorities held to the belief that the city could not spare the money to build any useful part of the network of subway routes projected. Later, however, they concluded that something must be done, and therefore authorized a call for bids on a short section, namely, part of the Fourth Avenue line lying in Brooklyn extending southerly from the Manhattan Bridge about two miles. The Rapid Transit Commission definitely resolved to call for bids for construction of this section, only a few weeks before the Commission was put out of office and superseded by the newly established Public Service Commission (July, 1907). Bids for building this section, known as the Fourth Avenue subway, were again delayed by various incidents for ten months longer. Finally in May, 1908, the Public Service Commission received bids on detailed plans worked out by the Commission's engineers, and awarded contracts. The idea at this time was to take up more extensive subway work, probably the Lexington Ave. route first of all, as soon as the Fourth Avenue work was started.

DISSENSIONS AMONG CITY AUTHORITIES.—A characteristic of the state of affairs during the next two years was a marked lack of harmony between the Board of Estimate and the new Public Service Commission. At times this was evidenced in disagreements and disputes, at other times merely in inactivity. This condition is responsible in large part for the fact that the Fourth Avenue subway was delayed for two years and further work for nearly three.

THE DEBT-LIMIT DISPUTE.—The Fourth Avenue subway having already been delayed by various trifles from July, 1907, to May, 1908, it was held up 18 months longer by a curious dispute originating among the city officials. The city's margin of bonding was conceded to be in excess of 15 or 16 million dollars, the approximate cost of the Fourth Ave. line; but one party

claimed that this margin would be consumed by more direct needs than subway work. There being a legal doubt as to what bonds of the city should be included in the debt computation, the matter was taken to court, and first of all an injunction against the Board of Estimate was asked for and obtained, prohibiting it from sanctioning the contracts until decision should be rendered. The litigation lasted until October, 1909, and no subway work was done in the meantime.

A favorable decision on the debt-limit question left the city free to go ahead with the Fourth Avenue work. Just before the 1909 election, which brought a new party into power, the Board of Estimate approved the contracts awarded nearly two years before. The bidders took up the contracts in spite of the lapse of time, and by December, 1909, work was started along the whole length of the Fourth Avenue section.

The judicial investigation had shown, moreover, that the city had a bond-issue margin which would suffice for much more subway work than merely that on Fourth Avenue. During the five years since the first subway was opened to traffic, the inadequacy of the latter to handle the growing transit needs was evident more and more strongly, since the conditions of crowding in the subway have for two years past surpassed the notorious crowding which prevailed at the Brooklyn Bridge terminal before the Battery Tunnel was opened. For these reasons it was clear, immediately after the court decision, that the construction of a new north-south subway in Manhattan should be undertaken at once.

LAST LEGAL DELAY REMOVED.—Even prior to this it would have been possible to proceed with the Lexington Ave. or another route, by enlisting private capital: The State legislature in 1908 changed the restrictive law which limited the life of future subway operating contracts, and established new provisions under which bidders would be sure of a safe investment. Early in 1909, then, the Lexington Ave. route could have been opened for bids, had it not been for a piece of early negligence in obtaining property-owners' consents. The original plan for the route showed a single-level subway, and apparently the original consents were obtained on this basis. Late in 1906 the plans were changed to make the subway double-deck for part of its length in Manhattan, Lexington Ave. and Broadway being narrow, and the surface grade of Lexington Ave. being so undulating that adherence to a surface grade (as necessary for the "local" tracks) would have been seriously hampering to operation on the "express" tracks. This change of design required a new reference to the courts to validate it, but such was not made until the middle of 1909. It appears that even the unsuccessful 1907 call for bids was made under the mistaken apprehension that the original validation held for double-deck construction.

The final decision of the courts validating the double-deck subway was rendered about a month ago, leaving the city authorities free to proceed. The debt-limit decision having been handed down only a few months before, all external obstacles to municipal construction are removed.

MUNICIPAL HARMONY.—The new city administration which came into office with the current year has recognized the imperative need for transit improvements, and has worked in harmony with the Public Service Commission in forwarding plans for new subway work. The outcome of their deliberations was the conclusion that construction contracts could be so drawn as to bind the city only for one year's expenditure at a time, which expedient will avoid burdening the city at the start with the full cost of the line. They decided also that both construction and combined construction and operation bids should be called for.

Between 1907 and 1910 the Public Service Commission had made close study of the routes projected in 1905 and 1906. These routes were more than simply lines on a map. A necessary legal preliminary to calling for bids is obtaining the consents of a majority of the owners of abutting property, or, if such cannot be obtained, obtaining a certificate of authorization from the Appellate Court. Such validation had been solicited and obtained by the Rapid Transit Commission for most of the routes it laid out, and the Public Service Commission therefore was free to take them up whenever it desired, provided only the Board of Estimate appropriated the money for construction.

THE INDETERMINATE FRANCHISE LAW.—The restrictive law regarding contracts for construction and operation was not changed until 1909. The most interesting provision of the new law is that which allows indeterminate franchises. Under such a franchise the operating company either equips or both builds and equips the line with its own money, and then remains in control of operation until its net earnings have repaid its entire investment with interest and suitable dividend, after which the property and the operating rights revert to the city; except that the city is privileged to buy the property and franchise at any time after ten years from completion. This law makes a subway enterprise a safe investment for the contractor, provided only it will have enough traffic to earn a dividend.

The central routes in New York City under present conditions are all of them capable of securing sufficient traffic. Outlying lines would be more precarious enterprises, at least for some years, or until they could develop their neighboring districts sufficiently to yield a paying traffic.

In the case of a through line such as the one now projected, the central portions are certain to obtain traffic enough to pay their cost, while the outlying parts are less attractive. For the development of the city it is necessary, however, that lines be built into districts which do not at first promise a heavy traffic, and on this account municipal construction is preferable or even necessary on certain routes.

ASSESSMENT ON PROPERTY.—A further provision of the new law is specially adapted to this condition. Where a line is unattractive to private capital and not important enough for the city at large to undertake, it may yet be so valuable to the outlying districts which it serves as to make the property-owners there willing to pay for part of the cost. The latter is permitted by the new law. On application of enough interested property-owners, the line may be built and part of its cost assessed on the property benefited.

This provision has not yet been actually used, and it is not intended to use it in building the lines now proposed. But if the Brooklyn Loop line is extended eastward, as is demanded by East Brooklyn residents, the extension would probably be built under the assessment-aid provision.

PLANNING A TRIBOROUGH SYSTEM.—Under these conditions the Commission has selected and recombined, from the routes laid out in 1905-06, such routes and parts of routes as seemed best adapted to furnish a comprehensive rapid-transit system reaching the maximum transit needs at most economical outlay. Some eight or nine of the validated routes were utilized, in whole or in part, to make up the Triborough line now recommended.

Many detail modifications from the original alinement have been made, some to suit the general purpose of planning an efficient system, some because of objections on the part of private interests. Thus, the original course of the Broadway-Lexington Ave. line (as shown on our map Dec. 27, 1906) was changed to turn from Broadway at Tenth Street into Lexington Ave. via private property and Irving Place, partly to avoid an unnecessary detour to the west, but also because of strong objection by property owners on Broadway. On the new alinement, however, it passed under or close to part of Grace Church, and complaint was promptly made that this edifice would be endangered. A further slight modification of alinement was necessary to meet this objection. Validation of these changes, obtained from the courts in January, 1909, completed the validation of the entire route except for the matter of double-deck subway construction on the major part of the Manhattan line as already noted.

CENTER ST. LOOP SUBWAY.—In the above sketch subway matters in New York City since 1904, no mention has been made of the Center Street Loop subway, extending from the City Hall, at the Manhattan end of the Brooklyn Bridge, north through Center and Delancey Sts. to a connection with the Williamsburgh Bridge. This was planned by the Rapid Transit Commission in 1905 as part of a loop over the Williamsburgh and Brooklyn Bridges, with an extension running out Broadway (Brooklyn) and another in Lafayette Ave. (Brooklyn). The Manhattan main trunk of this loop was the only part put under contract, about the middle of 1907.

This section by itself had no promise as a useful rapid-transit line, and though it is now substantially completed there is no prospect of putting it to use for some years to come. The Brooklyn Rapid Transit Co., operating surface and elevated lines in Brooklyn and crossing the Williamsburgh Bridge, was the only company that could establish a useful traffic through the Center St. Loop as built. But this company has declined to undertake running its Williamsburgh Bridge lines into the Loop subway. The present conditions will be unchanged until the Brooklyn part of the present Triborough project gives an effective transit line through the Loop, via the Lafayette Ave. and Broadway line in Brooklyn.

PRIVATE OR PUBLIC CAPITAL.—The city administration having decided that it can spare the capital to construct the entire line, it will invite bids for construction on public money for all parts of the Triborough system. If these bids are accepted, separate contracts for operation would be entered into. However, as the system is one which promises profitable operation with a high degree of certainty, there is a strong probability that private capital will offer to undertake construction in order to secure the operating contract. Therefore bids on combined construction, equipment and operation will also be invited.

In this connection the division of the system into three separate parts—the Bronx-Manhattan line, the Canal St. and Fourth Ave. line to Fort Hamilton and Coney Island, and the Brooklyn Loop line including the Center St. Loop subway—is very important. The three parts are essentially independent traffic routes, and may be so operated. But they can also be connected at their intersections by track connections, enabling through routing of trains, thus probably requiring that the whole operation be in the hands of one company. In order that the city may obtain the best advantage, it should permit operating bids to be submitted on each of the three sections separately, and also on combinations of the three sections. The present understanding is that this will be done, and that in the event of one bidder securing the contract for operating the whole system, track connection of the three sections will be specified.

STREET RAILWAY FREIGHT TRAFFIC.—The Montreal, Que., "Gazette" of Feb. 23 states that the Montreal Street Ry. Co. has announced the conditions which would be acceptable for the privilege of hauling freight about different parts of the city as desired by local merchants. Cars for the proposed freight service are not to run to exceed a speed of 12 mi. per hr. and in such a way as not to hinder the passenger traffic and not between the hours of 5 and 7 p. m. The company desires to have freight lines on such streets as the City Surveyor may indicate as suitable. The company proposes to use its buildings and yards for freight service. All cars are to be loaded and unloaded on the company's property or on the property of any individual or corporation having an agreement to that effect. It is proposed that, when the city shall determine to pave any street on which the company has tracks for freight haulage only, then the company shall pave, immediately and at its own expense with granite blocks or with other approved materials, the track space and 18 ins. on each side. The company proposes to sprinkle the streets, over which freight lines pass, three times a day with water given by the city. The snow will be removed from curb to curb along streets where a freight service only is maintained. The sum of 5% of the gross freight earnings, above $100,000 will be paid to the city.

The whole question now lies with the Board of Control which in due time will complete its examination and report to the city council.

Failure of a Wooden Roof from a Defective Splice.

By ARTHUR E. WINSLOW,* Assoc. M. Am. Soc. C. E.

The large granite shed of the firm of J. L. Burns & Co., situated at Northfield, Vt., suddenly collapsed on Feb. 26, 1910, just as the employees were going to work after a long lockout which had been settled the previous Saturday. Only two men were seriously hurt,

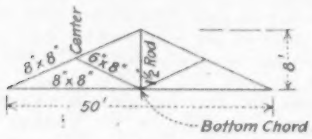


Fig. 1. Wooden Truss of Roof which Collapsed at Northfield, Vt.

and it is expected they will recover. The loss is estimated to be between $10,000 and $15,000.

The shed had a floor space 256 × 50 ft., and was covered with a roof supported by trusses of 50 ft. span c. to c. of end bearings, spaced 16 ft. apart on centers, of the type shown in Fig. 1. The rise of the trusses was 8 ft.

The excessive snow load, which at the time of failure I have estimated to be 50 lbs. per sq. ft., and the vibrations caused by the traveling crane were the probable cause of the collapse. Failure doubtless took place in the bottom chord at the splice.

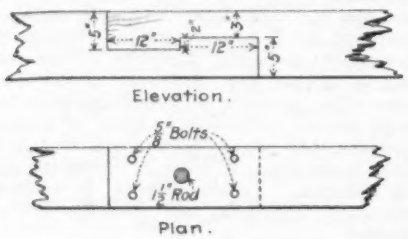


Fig. 2. Splice at Center of Bottom-Chord Timber.

Fig. 2 is a detail of the splice, and shows a faulty design for the loads which were probably placed upon it.

The building was designed and constructed by an old bridge foreman without knowledge of stresses in structures.

Reports on Specifications for Paving.

At the convention of city engineers and municipal officials, held in Chicago, Feb. 21 to 26, committees submitted drafts of specifications for paving, including materials and methods. These were adopted, but are not to be considered as standard, for the reason that they were prepared necessarily in a short time and without opportunity of thorough consideration by the committees or discussion by the convention. They are of sufficient interest and importance, however, to warrant us in presenting fairly complete abstracts of the specifications.

Report on Specifications for Macadam Paving

As macadam is one of the lowest classes of pavement and one of the most cheaply constructed, the general tendency seems to have been to pass over the specifications for its construction hurriedly. On the part of many engineers and city officials not nearly enough attention has been paid to details, but, the successful use of crushed rock as a paving material depends altogether on this same attention to detail.

While in the construction of any class or type of paving, local conditions of weather and traffic largely govern, it is in the construction of macadam pavements that the engineer must give greatest weight to surrounding circumstances. The kind and condition of the soil, the character and quality of the stone, the class and volume of traffic, must all be closely scrutinized and carefully considered in the preparation of specifications if first-class macadam construction is to result. In some localities a telford foundation is better and in others the macadam is considered superior. The committee has prepared specifications covering both forms.

A modern macadam pavement can hardly be considered finished until it has been given some binding treatment, and the specification has been prepared with a view to an ultimate treatment with some bituminous compound. We have considered treatment by penetration only, however, as other methods would more properly come before the committee on asphalt and bituminous macadam.

In the limited time available it has been impossible to go fully into the merits of the various tars and bitumens. We have endeavored to indicate a method of application which would generally be attended with successful results. However, in the use of these materials it is recommended that the engineers consult with the manufacturers and so amend this specification that it will comply with their requirements. It is further recommended that careful consideration be given the physical and chemical requirements of the bituminous treatment and that it be specified by such requirements rather than by trade name.

SUBGRADE.—The portion of the roadway indicated shall be excavated from the present surface thereof to a subgrade which, when properly prepared, shall be 14 ins. (for telford foundation), or 12 ins. (for macadam foundation), below and parallel with the surface of the completed pavement. Said completed surface shall conform to the general cross-section of the street as indicated and shall be thoroughly cleaned, all stumps, roots and sod or other vegetable matter being removed. The subgrade shall be rolled with a steam road roller weighing 10 tons, so the surface shall be exactly parallel with the proposed finished surface. All soft or spongy places shall be excavated and refilled solidly with gravel, broken stone or approved earth before the completion of the rolling. If, by reason of steep grades, or other circumstances, it is deemed impracticable to use the steam road roller the contractors will be permitted to use an approved horse-roller upon application to and with the consent of the proper authority.

TELFORD FOUNDATION.—Upon the subgrade thus prepared, there shall be placed a foundation of clean, hard, sound stone, broken into sizes which shall come within the following dimensions: 4 to 8 ins. wide, 8 to 14 ins. long, and not less than 8-ins deep. The stone shall be placed by hand vertically upon the broad edge and lengthwise across the roadway, so as to form a close, firm foundation from gutter to gutter. The projection of the stones above and below a surface 8-ins. above the subgrade shall be broken off with napping hammers and the pieces so broken off (together with other stones of suitable size and shape) shall be used as wedges to firmly fix the stone of the foundation in proper position, so that its top surface will be parallel to the subgrade of the roadway and 8-ins. above it.

Upon the roadway thus prepared there shall be spread a layer of good clean earth, preferably clayey loam, not to exceed 1-in. thick. The foundation shall then be thoroughly rolled with a steam road roller weighing not less than 10 tons. In places where rolling is impracticable, the foundation shall be rammed with suitable rammers with the approval of the proper authorities.

MACADAM FOUNDATION.—Upon the subgrade prepared in the manner above described, shall be spread a layer of broken stone which, when thoroughly compacted as herein provided shall be not less than 6 ins. deep. The stone in this layer shall be practically uniform in quality and as near an approach to a cube as possible, and broken so that its greatest dimension shall not exceed 4 ins. and the smallest dimension not less than 2 ins. All to be free from dust, dirt and screenings. All stones which do not approach uniformity of measurement shall be rejected and removed from the roadbed. No stones shall be allowed to remain which are not sound, strong and equal in size and quality. This layer of stone shall be thoroughly rolled with a steam road roller weighing not less than 10 tons, without the application of water.

SECOND COURSE.—On the above described foundation shall be placed a layer of broken stone whose greatest dimension shall not exceed 2 ins. and the least dimension shall not be less than ¾-in.; the depth of this layer, when compacted, shall be 4 ins. This stone shall be thoroughly rolled with a 10-ton steam roller, and sufficient clean stone screenings and water shall be spread over its surface to afford, when the rolling is completed, a practically smooth, dense and hard surface. When the second course as herein specified is completed, there shall be spread upon it a layer of stone ranging in size from 1-in. to ½-in. in the greatest dimension; this layer, when compacted, shall be 2 ins. in depth. This latter shall be thoroughly rolled and compacted with the 10-ton roller without the application of water until the stone ceases to creep before the rolls of the machine.

BITUMINOUS FILLER.—After the macadam shall have been thoroughly rolled, and when it is in a bone-dry condition, it is to receive a bituminous treatment applied as follows: The surface must be clean, free from dust, dirt or foreign matter. The bitumen must be applied in an approved manner and at a temperature of not less than — ° F., in sufficient quantity to cover all parts of the surface, and in quantity not less than 1½ gals., and not more than 2 gals. per sq. yd. After the application of the bitumen and after it has had time to set, there shall be applied a coating of clean stone chips whose greatest dimension shall not exceed ½-in. and whose smallest dimension shall not be less than ¼-in., sufficient to absorb all of the excess of bitumen. The whole shall be rolled until it presents a smooth, hard dense and granular surface.

The rolling herein specified must be begun generally at the curb or gutter line and rolled from curb to crown, the shoulders first being rolled so as to prevent the spreading of the stone.

Committee: James L. Darnell (Chairman), City Engineer, Kansas City, Mo.; W. H. Brooks, Asst. Commissioner of Highways, Philadelphia, Pa.; T. H. Richards, Asst. Supt. of South Parks, Chicago; H. R. Peterman, Asst. City Engineer, St. Joseph, Mo.; W. G. Leininger, Asst. Supt. of Streets, Chicago; H. W. Klausmann, City Engineer, Indianapolis, Ind.; Wm. Mengle, Chairman of Street Comm. (Bd. of Public Works), Newark, N. J.

Report on Specifications for Creosoted Wooden Block Paving.

The committee has discussed the question in every phase, and after giving careful consideration to the statements of the manufacturers it has decided to recommend the following as the principles upon which specifications shall be drafted, the idea being that these principles would be sufficient to enable any manufacturer to furnish a block that would conform to the specifications and at the same time permit the local engineer to adapt same to conditions in his particular city.

TIMBER.—The wood to be treated shall consist of long-leaf yellow pine, Norway pine, black gum and tamarack; only one kind of wood, however, to be used in any one contract.

Yellow pine blocks shall be cut from what is known as prime timber; namely, all timber must be sound commercial long-leaf yellow pine, well manufactured, full size, saw butted, all square edge, and shall be free from the following defects: unsound, loose and hollow knots, worm holes and knot holes, through shakes and round shakes that show on the surface. In yellow-pine timber the annual rings shall average not less than six to the inch, measured radially from the center of the heart.

Norway pine, gum and tamarack blocks shall be cut from timber that is first class in every respect, and shall be of the same grade as that defined for the yellow pine.

SIZE OF BLOCKS.—The blocks shall be from 5 to 10 ins. long, but shall average 8 ins.; they shall be 3½ and 4 ins. in depth, according to traffic; they shall be from 3 to 4 ins. wide, but all blocks in one street or improvement shall be of uniform width. It is provided that blocks 3 ins. deep can be used on residential streets and in alleys, but in no case shall the width and depth of the blocks be equal. A variation of 1/16-in. shall be allowed in the depth and ⅛-in. in the width of the blocks.

TREATMENT.—The blocks shall be treated with a preservative oil elsewhere described, so that the pine and tamarack blocks shall contain not less than 20 lbs. and the gum blocks not less than 22 lbs. per cu. ft.

OIL.—The oil used shall be a coal-tar product, free from adulteration of any kind, and shall comply with the following requirements: (1) The specific gravity shall be at least 1.10 at a temperature of 38° C. (2) Not more than 3% of the oil shall be insoluble by hot continuous extraction with benzol and chloroform. (3) On distillation (which shall be made exactly as described in Bulletin No. 65 of the American Railway Engineering and Maintenance of Way Association), the distillate shall not exceed 2% up to 150° C. and 35% up to 315° C. The mean of three determinations is to be taken.

The manufacturer of the oil shall permit full and complete inspection and sampling at the factory at which the oil is produced, of all materials (either crude or refined) entering into the manufacture of the finished product, as well as the finished product itself, in order that the materials used can be determined to be in accordance with the foregoing requirements. He shall also submit satisfactory proof of the origin of all materials entering into the composition of the finished product.

Oil samples taken by the inspector from the treating tank during progress of the work shall at no time be allowed to show an accumulation of more than 2% of foreign matter, such as sawdust and dirt. Due allowance shall be made for such accumulation of foreign matter by injecting an additional quantity of oil into the blocks.

CUSHION.—The blocks shall be laid on a sand cushion 1 in. thick placed upon the concrete foundation.

FILLER.—The joints between the blocks shall be filled with pitch or fine sand, the particular kind to be determined by the local authorities as conditions may demand.

EXPANSION JOINTS.—An expansion joint shall be laid along the curb, and transverse joints ½-in. wide every 50 ft. along the street. These joints to be filled

*Professor of Civil Engineering, Norwich University, Northfield, Vt.

with a bituminous composition, the necessity of the transverse joints to be determined by the local authorities, according to climatic conditions.

Committee—George W. Tillson, Chief Engineer, Bureau of Highways, New York City; Andrew Rinker, Chief Engineer, Minneapolis, Minn.; George S. Smith, Commissioner of Public Works, New Orleans, La.; N. S. Sprague, Supt. Bureau of Construction, Pittsburg, Pa.; Jas. C. Travilla, Member Board of Public Improvements and Street Commissioner, St. Louis, Mo.; Thos. F. McGilvray, City Engineer, Duluth, Minn.; William F. Harvey, Asst. Engineer, Board of Local Improvements, Chicago, Ill.; H. L. Conway, Engineer in Charge Street and Sewer Repair Dept., Cincinnati, O.; J. K. Mitchell, General Asst. City Engineer, Detroit, Mich.; Albert F. Keeney, President, Board of Local Improvements, Chicago, Ill.

Specifications for Brick and Granite Block Paving.

BRICK.—All brick must be strictly No. 1 pavers of the size commercially known as block, the widths of which must not vary more than ¼-in. They must be thoroughly annealed, tough and durable, regular in size and shape, and evenly burned. When broken, the block shall show a dense stone-like body, uniform in color inside, free from lumps of uncrushed clay, lime, air pockets, cracks or marked laminations; kiln marks or surface cracks must not exceed 3/16-in. in depth. All blocks so distorted in burning as to lay unevenly in the pavements shall be rejected. All blocks shall be tested for abrasion and absorption. The limits of loss by abrasion test and amount of absorption to be determined by the engineer in charge of the work.

The abrasion test shall be made with the rattler recommended by the National Paving Brick Manufacturers' Association and of the following shape and dimensions: A regular 14-sided polygon, circumscribed around a circle 28 ins. in diameter, and the barrel to be 20 ins. long with ¼-in. spaces between each side; where cast-iron staves are used, the engineer in charge of the work shall require greater loss from abrasion than when steel is used.

NOTE.—In view of the fact that the National Paving Brick Manufacturers' Association is now considering a modification as to dimensions and materials of the "rattler," now and for some time in use, the committee advises that questions touching the "rattler" be not considered until after the association has reached a conclusion and made a recommendation as to this appliance.

All blocks shall be laid on a 6-in. concrete base with sand cushion. The cushion shall be of clean, sharp sand, spread to a uniform surface to conform to the cross-section of the finished pavement; the sand cushion to be slightly moistened and rolled with a hand roller weighing not less than 10 lbs. per inch of width. The depth of sand to be not less than 1½ ins., nor more than 2 ins. after rolling.

CEMENT FILLER FOR BRICK PAVEMENTS.—The filler shall be composed of 1 part each of clean sharp sand and Portland cement. The sand should be dry. The mixture, not exceeding ½-bushel of the sand, together with a like amount of cement, shall be placed in the box and mixed dry, until the mass assumes an even and unbroken shade. Then water shall be added, forming a liquid mixture of a consistency of thin cream.

The sides and edges of the brick should be thoroughly wet before the filler is applied by being gently sprinkled.

From the time the water is applied until the last drop is removed and floated into the joints of the pavement, the mixture must be kept in constant motion.

The mixture must be removed from the box to the street surface with a scoop shovel, all the while being stirred in the box as the same is being thus emptied. The box for this purpose shall be 4 ft. 8 ins. long, 30 ins. wide and 14 ins. deep, resting on legs of different lengths, so that the mixture will readily flow to the corner of the box, the bottom of which should be 6 ins. above the pavement. This mixture, from the moment it touches the brick, should be thoroughly swept in to the joints. Two such boxes shall be provided in case the street is 20 ft. or less in length; or three boxes if it exceeds 20 ft. in width.

The work of filling should thus be carried forward in line until an advance of 15 to 20 yds. has been laid, when the same force and appliances shall be turned back and cover the same space in like manner, except to make the proportions 2 parts Portland cement and 1 part sand.

To avoid the possibility of thickening at any point, there should be a man with a sprinkling can (the head perforated with small holes) sprinkling gently the surface ahead of the sweepers.

Within ½ to ¾-hour after this last coat is applied and the grout between the joints has fully subsided, and the initial set is taking place, the whole surface must be slightly sprinkled and all surplus mixture left on the tops of the brick swept into the joints, bringing them up flush and full.

After the joints are thus filled flush with the top of the brick and sufficient time for hardening has elapsed, so that the coating of sand will not absorb any moisture from the cement mixture, ½-in. of sand shall be spread over the whole surface. In case the work is subjected to a hot summer sun, an occasional sprinkling (sufficient to dampen the sand) should be followed for two or three days.

NOTE.—If a stronger filler is desired, pure cement may be used. Where streets cannot be kept closed long enough to permit cement grout to properly set (or on account of any other local conditions), a bituminous filler may be used.

After brick in pavements are inspected and the surface is swept clean, the pavement shall be rolled with a roller weighing not less than 3 nor more than 5 tons, in the following manner. The brick next the curb shall be tamped with a hard wood tamper to the proper grade. The rolling will then commence near the curb at a very slow pace and continue back and forth towards the center, until the center of the street is reached; then passing to the opposite curb and repeating in the same manner to the center of street. After this first passing of the roller, the pace may be quickened and the rolling continued until each brick is firmly imbedded in the sand cushion. The pavement shall be rolled transversely at an angle of 45° from curb to curb, repeating the rolling in opposite 45° direction. Before and after this transverse rolling has taken place, all broken or injured blocks must be taken up and replaced with perfect ones. The substituted blocks must be brought to the true surface by tamping.

Expansion joints shall be placed parallel with and at each of the curb lines, and shall be not less than 1 in. in width. These joints shall be filled completely with bituminous cement.

GRANITE BLOCK AND SIMILAR STONE BLOCK PAVEMENTS.—The committee decided at this time to recommend only certain dimensions and features in regard to the blocks themselves, rather than a complete set of specifications for this form of pavement. It is believed that the adoption of certain standard dimensions for the blocks will result in having the several quarries improve the output of paving blocks, and enable them to furnish a standard block more expeditiously, and (it is hoped) at not to exceed the cost which now maintains.

DIMENSIONS OF BLOCKS.—(1) The depth of block shall be 5 ins., with an allowable variation of ¼-in. over and under this depth. (2) The blocks shall be so dressed that they can be laid with ½-in. joint for a distance of 1 in. down from the head, the individual joints to be measured. The joint not to exceed ¼-in. at the top, nor to be more than 1-in. in any part of the joint. (3) The block to be from 8 ins. to 12 ins. long. (4) The block to be from 3½ to 4½ ins. in width for ordinary conditions, with a suggestion of greater width to be allowed for streets of flat grades; said width to be specified in each individual contract. (5) The head of the block shall be so dressed that it shall not have more than ⅜-in. depression from a straight edge laid in any direction across the head and held parallel to the general surface of the block.

Committee—B. E. Fendall (Chairman), City Engineer, Baltimore, Md.; M. F. McKenna, City Engineer, Bridgeport, Conn.; D. M. Roberts, City Engineer, Terre Haute, Ind.; John Minwegen, Board of Local Improvements, Chicago; M. R. Sherrerd, Chief Engineer, Dept. Public Works, Newark, N. J.; Edward H. Christ, Member Board Public Works, Grand Rapids, Mich.; A. N. Aldrich, Mayor, Aberdeen, S. D.; W. K. Seitz, Asst. City Engineer, St. Joseph, Mo.; John B. Hittell, Chief Engineer of Streets, Chicago; J. A. Hooke, Asst. Sewer Commissioner, St. Louis.

Tests Upon the Effect of Sea Water on Cement-Sand Mortar Briquettes.*

By CLOYD M. CHAPMAN.†

Of the many theories and opinions now advanced to explain the change which takes place in concrete when exposed to sea water, the most plausible are those which attribute the action to a slow solution by the water of some constituent of the cement or a slow deposition in the concrete of some constituent of the sea water, or both. But those theories are necessarily based on the assumption that water enters and leaves the concrete or percolates through it, carrying something with it or leaving something behind. Put in waterproof concrete and the percolation will stop. Stop the percolation and the action will stop, and the concrete will remain unaffected.

In order to get more light on the effect of sea water upon concrete, Westinghouse, Church, Kerr & Co., of New York made a series of experiments upon the tensile strength of cement mortar immersed for various periods in sea water. Three series of standard briquettes were made up. The first series were mixed with fresh water and kept immersed in fresh water until broken. The second series were mixed with fresh water and kept immersed in sea water. The third series were mixed with sea water and immersed in sea water. The cement used was a very well known and representative brand of American Portland cement. The sand used was Standard Ottawa River sand between 20 and 30 mesh. The proportions of cement and sand varied from 1:1 to 1:6 by weight. Mixtures of the proportion of 1:7 were also made but as they all crumbled in the pans after a short time, they were discarded from the test. Briquettes were of standard size, with 1 sq. in. of cross section. They were kept in a damp closet for 24 hours after making, and then immersed in water in pans in the laboratory. Water from New York Harbor, taken at flood tide,

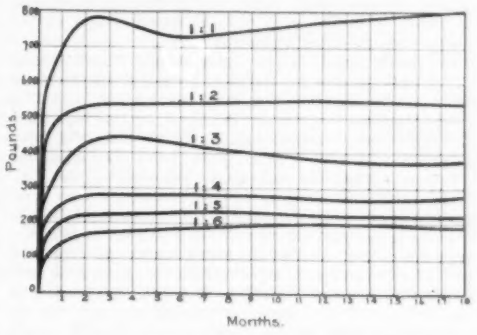


Fig. 1. Cement-Sand Mortars Mixed and Kept in Fresh Water.

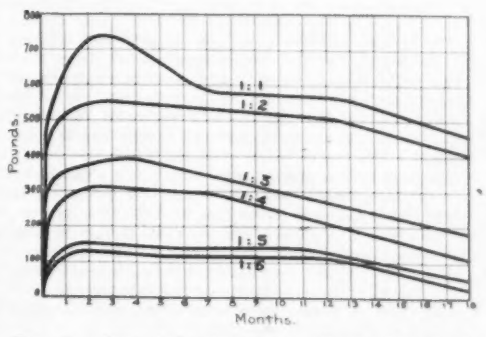


Fig. 2. Cement-Sand Mortars Mixed with Fresh and Kept in Sea Water.

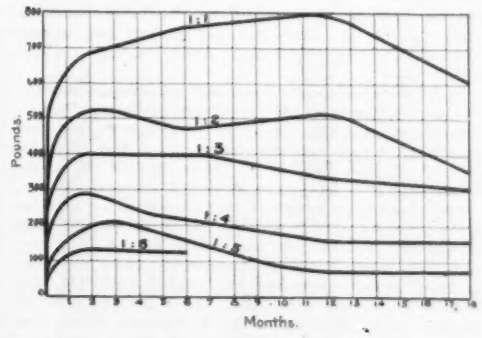


Fig. 3. Cement-Sand Mortars Mixed and Kept in Sea Water.

was used in the pans containing the second and third series. This water was changed frequently.

Three briquettes of each proportion in each series were broken at the end of 7 days, 28 days, 2 months, 6 months, 12 months, and 18 months.

The results obtained are shown graphically by the curves given herewith. They tell their own story.

It is unwise to draw conclusions from meager information. These tests do not represent practical conditions. They are tension tests, while concrete is seldom subjected in practice to tensile stresses. The specimens were only 1-in. square at the breaking point and concrete is seldom, if ever, used in that size in sea water. The small area of cross-section made it necessary for the action of the sea water to penetrate only ½-in. into each side of the test piece to affect the entire cross-section. Whereas, on a pier of large size in sea water, the concrete would be damaged but a small percentage if ½-in. were entirely removed from its surface, yet successive removals of ½-in. at a time would ultimately be very injurious.

These results are presented, not with the claim that they support any theory or that they prove any point in the question of how to make concrete withstand the ravages of sea water, but as a record of tests made and results obtained which furnish evidence that the effect of sea water upon cement-sand mortar is to reduce its tensile strength.

*Paper read before the Annual Convention of the National Association of Cement Users, Chicago, Ill., Feb. 21-25, 1910.

†Engineer, Westinghouse, Church, Kerr & Co., New York.

Test of the 15,000-KW. Steam-Engine-Turbine Unit in the Power Station of the Interborough Rapid Transit Co., New York City.*

By H. G. STOTT,† M. Am. Soc. M. E., and R. J. S. PIGOTT.

During the year 1908 it became apparent that owing to the fast increasing traffic in the New York subway, it would be necessary to have additional power available for the winter of 1909-1910.

The power plant of the Interborough Rapid Transit Co., which supplies the subway, is located on the block bounded by 58th and 59th Sts., and by 11th and 12th Aves., adjacent to the North River; it contains nine 7,500-KW. (maximum rating) engine units, besides three 1,250-KW. 60-cycle turbine units which are used exclusively for lighting and signal purposes.

The 7,500-KW. units consist of Manhattan-type compound Corliss engines, having two 42-in. horizontal high-pressure cylinders and two 86-in. vertical low-pressure cylinders. Each horizontal high-pressure cylinder and vertical low-pressure cylinder has its connecting rod attached to the same crank, so that the unit becomes a four-cylinder 60-in. stroke compound engine with an overhanging crank on each side of a 7,500-KW. maximum rating 11,000-volt, three-phase, 25-cycle generator. The generator revolving field is built up of riveted steel plates of sufficient weight to act as a flywheel for the two engines connected to it. This arrangement gives a very compact two-bearing unit. The valve gear on the high-pressure cylinders is of the poppet type, and on the low-pressure of the Corliss double-ported type.

The condensing apparatus consists of barometric condensers, arranged so as to be directly attached to the low-pressure exhaust nozzles, with the usual compound displacement circulating pump and simple dry-vacuum pump.

These engine and generator units are in general probably the most satisfactory large units ever built, as five years' experience with them has proved; their normal economic rating is 5,000 KW., but they operate equally well (water rate excepted) on 8,000 KW. continuously.

In considering the problem of how to get an additional supply of power, every available source was considered, but by a process of elimination only two distinct plans were left in the field.

The electric transmission of power from a hydraulic plant was first considered, but owing to the high cost of a double transmission line from the nearest available water power, and the impossibility of getting reliable service (that is, service having a maximum total interruption of not more than ten minutes per annum) from such a line further consideration of this plan was abandoned.

The gas engine, while offering the highest thermodynamic efficiency at the same time required an investment of at least 35% more than an ordinary steam-turbine plant with a probable maintenance and operation account of from four to ten times that of the steam turbine.

The reciprocating-engine unit of the same type as those already installed, was rejected in spite of its most satisfactory performance, on account of the high first cost and small range of economical operation. The economic limits of operation are between 3,300 KW. and 6,300 KW.; beyond these limits the water rate rises so rapidly as to make operation undesirable under this condition, except for a short period during peak loads.

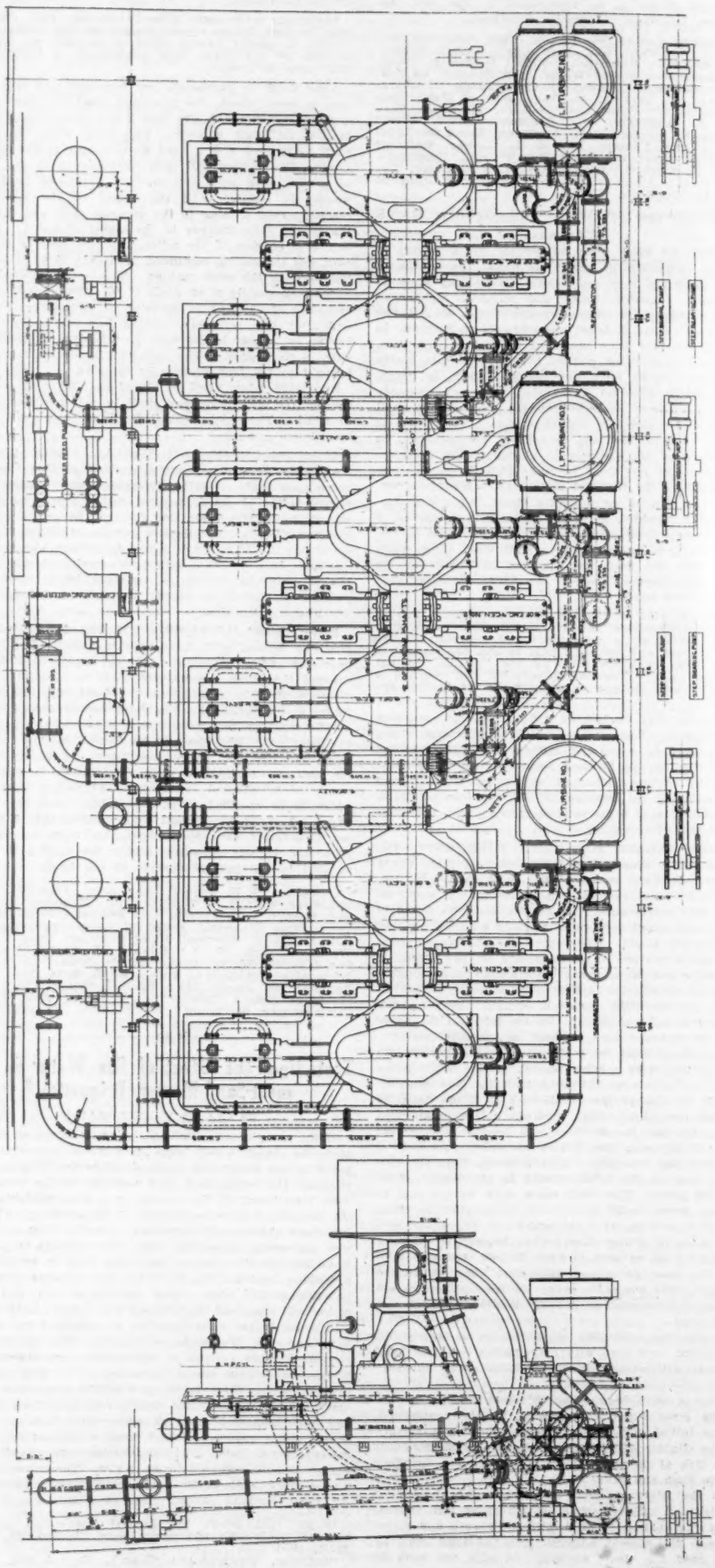
The choice was thus narrowed down to either the high-pressure steam turbine or the low-pressure steam turbine. There was sufficient space in the present building to accommodate three 7,500-KW. units of the high-pressure type, or a low-pressure unit of the same size on each of the nine engines, so that the questions of real estate and building were eliminated from the problem.

The first cost of a low-pressure turbine unit is slightly lower than that of a high-pressure unit, due to the omission of the high pressure stages and the hydraulic governing apparatus, but the cost of the condensing apparatus would be the same in both cases. The foundations and the steam piping in both cases would not differ greatly. The economic results, so far as the first cost is concerned, would then be approximately the same, if we consider the general case only; but in this particular instance the installation of high-pressure turbines would have meant a much greater investment for foundations, flooring, switchboard apparatus, steam piping and water tunnels, amounting to an addition of not less than 25% to the first cost.

The general case of displacing reciprocating engines and installing steam-turbine units in their place was also considered. The best type of high-pressure turbine plant has a thermal efficiency approximately 10% better than the best reciprocating-engine plant, but the items

*A paper read at the meeting of the American Society of Mechanical Engineers on March 8 and published in the Society's "Journal" for March.

†Interborough Rapid Transit Company.



END ELEVATION AND PLAN OF ENGINE AND LOW-PRESSURE TURBINE UNITS; 59TH STREET STATION, INTERBOROUGH RAPID TRANSIT COMPANY.

of labor for operation and for maintenance, together with the saving of about 85% of the water for boiler-feed purposes and the 10% of coal, reduce the relative operating and maintenance charges for the steam-turbine plant of 80%, as compared to 100% for the reciprocating-engine plant.

Assuming that the reciprocating-engine plant is a first-class one and has been well maintained, about 20% of its original cost (for engines, generators and condensers) may be realized on the old plant and so credited to the cost of the high-pressure turbine plant. But on the other hand, if the high-pressure turbine installation is to receive credit for the second-hand value of the engines, it must also have a debit charge for 100% of the original reciprocating-engine plant which it displaced. The relative investments, therefore, upon this basis would be approximately equal for the high-pressure or the low-pressure turbine; but 80% of the cost of the original engine plant would have to be charged against the high-pressure turbine plant, as against an actual increase in value (to the owner) of the engine by reason of its improved thermal efficiency, due to the addition of the low-pressure turbine.

The preliminary calculations, based upon the manufacturers' guarantees for the low-pressure and high-pressure turbines, showed that the combined engine-turbine unit would give at least 8% better efficiency than the high-pressure turbine unit, so that it was finally decided to place an order for one 7,500-KW. (maximum rating) unit, as by this means we would not only get an increase of 100% in capacity, but at the same time give the engines a new lease of life by bringing them up to a thermal efficiency higher than that attained by any other type of steam plant.

The turbine installed is of the vertical three-stage impulse type having six fixed nozzles and six which can be operated by hand, so as to control the back pressure on the engine, or the division of load between engine and turbine. An emergency overspeed governor, which trips a 40-in. butterfly valve on the steam pipe connecting the separator and the turbine and at the same time the 8-in. vacuum breaker on the condenser, is the only form of governor used. The footstep bearing, carrying the weight of the turbine and generator rotors, is of the usual design supplied with oil under a pressure of 600 lbs. per sq. in. with the usual double system of supply and accumulator to regulate the pressure and speed of the oil pumps.

The condenser contains approximately 25,000 sq. ft. of cooling surface arranged in the double two-pass system of water circulation with a 30-in. centrifugal circulating pump having a maximum capacity of 30,000 gals. per min. The dry vacuum pump is of the single-stage type, 12-in. and 29-in. by 24-in., fitted with Corliss valves on the air cylinder. The whole condensing plant is capable of maintaining a vacuum within 1.1 in. of the barometer when condensing 150,000 lbs. of steam per hr. when supplied with circulating water at 65° F.

The electric generator is of the three-phase induction type, star-wound for 11,000 volts, 25 cycles and a speed of 750 r. p. m. The rotor is of the squirrel-cage type with bar winding connecting into common bus-bar straps at each end. This type of generator was chosen as being specially suited to the conditions obtaining in the plant.

With nine units operating in multiple, each one capable of giving out 15,000 KW. for a short time, operating in multiple with another plant of the same size, it is evident that it is quite possible to concentrate 270,000 KW. on a short circuit. If we proceed to add to this, synchronous turbine units of 7,500-KW. capacity, which, owing to their inherently better regulation and enormous stored energy, are capable of giving out at least six times their maximum rated capacity, the situation might soon become dangerous to operate, as it would be impossible to design switching apparatus which could successfully handle this amount of energy. The induction generator, on the other hand, is entirely dependent upon the synchronous apparatus for its excitation, and in case of a short circuit on the bus-bars would automatically lose its excitation by the fall in potential on the synchronous apparatus.

The absence of fields leads to the simplest possible switching apparatus, as the induction generator leads are tied in solidly through knife switches, which are never opened, to the main generator leads. The switchboard operator has no control whatever over the induction generator, and only knows it is present by the increased output on the engine generator instruments.

The method of starting is simplicity itself—the exciting current is put on the engine generator before starting the engine, and then the engine is started, brought up to speed and synchronized in exactly the same way as before. While starting in this way, the induction generator acts as a motor until sufficient steam passes through the engine to carry the turbine above synchronism, when it immediately becomes a generator and picks up the load. Three of these 7,500-KW. low-pressure turbine units have been installed and tests run on Nos. 1 and 2. No. 3, having been just started, has not yet been tested.

Instead of inserting in this paper the enormous accumulation of data incident to these tests, we have divided the paper into two parts in the hope that it would thus be more accessible for reference, the first part giving the reasons for adopting this particular type of apparatus, with a brief description of the plant and a summary of the results obtained, and the second part containing all the principal data acquired during the tests, with sufficient explanation to make their meaning clear without reference to the text.

[The tables and diagrams are so voluminous that we reprint here only one table giving the chief results of the tests on combined unit No. 2. The tests on this unit were made under the best conditions for accuracy.—Ed.]

In all results, except where specially noted, moisture corrections are simple corrections, i. e., for each per cent. of moisture only 1% correction has been made. Vacuum corrections for the combined unit are 1 lb. for each inch variation from 28.5 ins. when referred to 29.92 ins. barometer.

The net results obtained by the installation of low-pressure turbine units may be summarized as follows:

1. An increase of 100% in maximum capacity of plant.
2. An increase of 140% in economic capacity of plant.
3. A saving of approximately 85% of the condensed steam for return to the boilers.
4. An average improvement in economy of 13% over the best high-pressure turbine results.
5. An average improvement in economy of 25% (between the limits of 7,000 KW. and 15,000 KW.) over the results obtained by the engine units alone.
6. An average unit thermal efficiency between the limits of 6,500 KW. and 15,500 KW. of 20.6%.

A RENEWABLE SEAT FOR GLOBE VALVES has been recently patented and is known as the Huxley valve seat. It consists of a short, thin, slightly tapered cylindrical shell with a lip projecting outward around the upper edge. The Huxley seat is pressed down into the seat opening in the valve body, which is made specially to fit it, and its lip fits down over the projecting upper edge of the valve seat opening. Either the top or the beveled portion of the lip forms the contact surface for the valve, depending on whether a flat or conical valve disk is used. If the seat becomes cut, it can be taken out and a new one put in without using special tools. Thus there is no need of regrinding and the life of the valve body in ordinary service is practically unlimited. The cost of new Huxley seats is only a few cents. Valves equipped with these seats in conjunction with renewable disks are being placed on the market by the Nelson Valve Co., Chestnut Hill, Philadelphia.

TABLE SHOWING MAIN RESULTS OF TESTS ON COMBINED ENGINE-TURBINE UNIT NO. 2, INTERBOROUGH POWER HOUSE.

			Loads, KW.			Pressures.				Temperatures, Degrees Fahr.						
No. Test.	Date, Jan., 1910.	Duration. hrs.	Total unit.	Engine.	Turbine.	Mn. Stm. pipe gage per sq. in.	Rec. gage, lbs. per sq. in.	L. P. Sep. U Tube "Hg.	Vacuum Hg. Col. "Hg.	Barometer "Hg.	Avge. mn. stm.	Avge. rec.	East eng. exh.	Turbine bowl.	Condenser.	Hot well water.	Circ. water injection.	Circ. water discharge.
38	11	5	16,172	8,344	7,784	182.3	49.5	10.94	28.30	30.63	380.6	297.2	230.5	228.5	90.90	71.20	37.66	57.28
39	11	5	13,485	7,738	5,895	189.1	49.8	2.61	29.10	30.59	383.4	297.4	218.7	217.0	94.60	76.23	39.85	62.51
40	12	5	13,038	7,314	5,711	181.4	49.1	1.82	29.46	30.61	380.2	296.8	218.0	216.1	84.45	70.97	32.03	51.84
41	12	5	12,284	6,938	5,348	185.5	49.8	2.18	29.32	30.57	381.9	297.3	217.9	216.3	87.17	73.41	33.95	56.76
42	13	5	11,252	6,248	4,938	182.3	49.3	2.20	29.41	30.65	380.6	297.0	218.6	216.9	87.18	75.25	31.82	56.67
43	13	5	10,476	5,824	4,602	183.3	49.1	2.00	29.23	30.58	381.0	296.7	217.9	216.3	89.82	80.17	32.75	57.14
44	14	5	9,408	4,940	4,426	184.1	49.1	2.28	29.47	30.31	381.3	296.7	217.6	216.1	73.87	59.42	31.63	41.98
45	14	1¾	9,712	5,916	3,709	183.5	49.6	−7.48	28.96	30.21	381.1	297.3	208.2	196.7	86.72	66.20	32.22	43.97
46	15	¼	12,700	7,180	5,640	183.8	47.9	−2.78	29.45	30.32	381.2	295.5	209.0	208.0	77.20	63.70	40.20	53.10
47	15	½	11,940	7,060	4,780	180.6	47.9 49.1	−1.80	29.72	30.32	379.9	295.6 296.7	205.0 193.7	204.0 192.5	80.00	63.00	36.00	40.85
48	15	3	9,306	5,865	3,323	181.5	51.6	−10.49	29.13	30.33	380.3	276.1	190.5	189.4	84.86	60.58	32.90	42.06
49	15	1	10,940	6,640	4,300	180.2	35.6	−6.62	29.19	30.32	379.7	280.0	202.0	201.0	83.50	62.60	31.38	53.80
50	15	4	15,498	8,169	7,260	177.3	44.3	3.54	29.23	30.32	378.5	291.5	222.6	221.0	82.23	65.69	31.51	50.08
51	17	3	11,240	6,753	4,376	179.3	40.3	−6.71	29.25	30.38	379.4	287.0	203.4	199.8	83.16	65.18	37.50	43.10
52	17	3	7,200	4,743	2,400	181.8	26.8	−14.92	29.07	30.29	380.4	269.6	183.8	180.8	85.70	58.15	31.47	32.81
53	17	3	11,927	7,070	4,834	184.3	38.2	4.58	29.10	30.26	381.4	284.4	205.7	204.6	83.65	65.65	31.46	45.37
54	26	3	14,173	7,820	6,283	178.6	40.9	1.04	29.31	30.03	379.1	287.9	215.6	213.3	81.20	57.26	33.54	47.77
55	26	3	8,347	5,403	2,910	182.7	28.3	−13.48	28.90	29.97	381.8	271.7	187.0	183.8	81.00	58.64	33.08	41.30
56	26	3	13,033	7,457	5,550	182.5	39.6	−1.75	29.01	29.90	380.7	286.2	209.3	207.6	74.70	60.72	33.40	50.10
57	27	3	14,580	7,960	6,583	179.2	45.1	+3.04	28.85	29.49	379.2	292.3	217.5	215.5	67.41	53.21	33.28	47.61
58	27	3	6,673	4,420	2,213	183.2	25.6	−15.14	28.48	29.48	380.9	267.7	177.4	176.3	78.20	53.85	33.18	39.46
59	27	3	10,007	6,104	3,804	184.6	32.0	−8.80	28.55	29.50	381.5	277.5	195.7	194.1	78.80	59.12	33.40	43.66
60	28	3	11,820	6,923	4,860	180.5	36.9	−4.98	28.96	29.79	379.8	283.1	204.4	202.4	74.04	59.60	33.25	46.00
61	28	3	11,480	6,587	4,893	182.2	36.7	−4.46	28.88	29.79	380.5	282.8	205.0	203.2	77.18	61.74	33.06	47.23
62	28	3	15,860	8,440	7,410	180.4	48.8	7.60	28.73	29.79	379.7	296.3	223.9	221.8	82.42	62.79	33.64	56.00

			Water Rates, lbs. per KW.-hr.						Efficiencies							Heat to Cond.		
									Rankine Efficiencies.			Thermal Eff. Ref'd to Rankine.			Thermal eff. Recov. H.W. Water.			
No. Test.	Date, Jan., 1910.	Duration hrs.	Actual Unit.	Actual Eng.	Actual Turb.	Corr. Unit Moist Only.	Corr. Unit Total Corr.	Factor I.HP. KW.	Eng. %	Turb. %	Unit %	Eng. %	Turb. %	Unit %	Eng. %	Turb. %	Unit %	Ratio Cold water ÷ by steam.	B.T.U. per sq. in. per sec.	B.T.U. per sq. in. per sec. per deg. rise.
38	11	5	15.07	29.64	27.51	14.40	14.10	1.404	16.7	18.2	30.1	70.3	60.6	65.0	11.7	10.9	19.5	53.5	2.58	.0504
39	11	5	14.82	24.76	28.38	13.48	13.10	1.404	16.8	16.8	29.1	81.5	63.5	70.5	13.7	10.7	20.5	48.2	1.99	.0459
40	12	5	13.92	24.78	27.35	13.44	13.42	1.447	17.8	18.4	30.8	76.9	60.0	68.5	13.7	11.0	21.1	52.9	1.86	.0437
41	12	5	13.88	24.57	27.51	13.39	13.28	1,457	17.6	17.7	30.4	78.5	62.3	69.7	13.8	11.0	21.2	46.4	1.77	.0428
42	13	5	13.87	24.99	27.72	13.54	13.42	1.374	17.4	17.8	30.8	76.4	61.8	70.1	13.6	11.0	21.2	42.7	1.65	.0384
43	13	5	13.85	24.90	27.91	13.47	13.21	1.460	17.3	17.7	30.2	78.9	60.5	70.7	13.6	11.4	21.4	44.2	1.53	.0345
44	14	5	13.75	16.19	25.53	13.32	13.59	1.470	17.6	18.8	29.4	73.2	62.5	71.8	12.9	11.7	21.1	107.7	1.37	.0309
45	14	1¾	13.72	22.53	30.59	13.40	13.45	1.385	....	....	....	....	....	....	....	....	....	....	....	....
46	15	¼	13.99	24.75	27.38	13.62	13.77	1.575	....	....	....	....	....	....	....	....	....	....	....	....
47	15	½	13.30	22.49	28.45	13.15	13.31	1.475	....	....	....	....	....	....	....	....	....	....	....	....
48	15	3	13.44	21.34	31.84	13.25	13.25	1.441	20.5	15.6	30.5	74.9	61.2	71.0	15.4	9.5	21.7	118.	1.26	.0266
49	15	1	13.69	22.40	29.50	13.39	13.46	1.444	....	....	....	....	....	....	....	....	....	....	....	....
50	15	4	14.22	26.99	26.55	13.96	14.03	1.421	....	....	....	....	....	....	....	....	....	....	....	....
51	17	3	13.19	21.95	28.80	13.04	13.04	1.456	19.7	16.4	30.8	76.7	53.6	72.0	15.1	10.5	22.2	150.	1.28	.0268
52	17	3	13.67	20.75	35.04	13.52	13.43	1.505	....	....	....	....	....	....	....	....	....	....	....	....
53	17	3	13.38	22.57	28.22	13.13	13.08	1.400	....	....	....	....	....	....	....	....	....	....	....	....
54	26	3	13.66	24.75	27.22	13.54	13.81	1.400	18.2	18.7	31.2	74.5	59.1	68.1	13.6	11.1	21.2	77.1	2.08	.0612
55	26	3	13.34	20.60	32.85	13.23	13.28	1.425	21.2	17.5	30.5	74.6	52.6	71.5	15.8	9.2	21.8	112.	0.92	.0270
56	26	3	13.40	23.43	27.72	13.28	13.47	1.373	18.2	18.4	31.0	78.5	59.4	69.0	14.2	10.9	21.7	63.4	1.87	.0566
57	27	3	13.75	25.19	26.95	13.65	14.00	1.388	18.0	19.5	32.2	74.0	57.0	65.4	13.6	11.1	21.0	77.5	2.16	.0800
58	27	3	13.76	20.78	35.27	13.65	13.87	1.460	21.3	14.6	31.4	73.2	59.0	67.0	15.6	8.6	21.0	153.	2.55	.0908
59	27	3	13.30	21.48	30.38	13.13	13.39	1.413	19.5	16.7	31.3	78.5	60.0	69.8	15.3	10.0	21.8	108.	1.41	.0336
60	28	3	13.38	22.84	28.41	13.28	13.61	1.431	19.5	20.2	32.2	74.8	52.9	67.6	14.5	10.7	21.8	82.0	1.67	.0485
61	23	3	13.92	24.45	24.22	13.75	13.95	1.414	19.6	17.6	31.4	69.8	60.4	66.9	13.7	10.7	21.0	108.	2.40	.0895
62	28	3	14.14	26.58	26.56	13.99	13.99	1.456	17.2	18.7	30.0	74.0	59.4	68.9	12.7	11.1	20.7	49.6	2.52	.0979

Cantilever Construction and Wind-Bracing Details in the People's Gas Light & Coke Co. Building, Chicago.

The new building now being erected for the People's Gas Light & Coke Co. at Michigan Ave. and Adams St., Chicago, is an office building 21 stories high and about 1.. × 195 ft. in plan. It is of steel frame construction, and from a structural point of view it is remarkable in having the upper 18 stories of each street front carried on cantilevers having a projection of 4 ft. 5 ins. This arrangement, with the lower sections of the columns set back from the front of the building, was adopted in order to allow of placing at the building line a row of monolithic granite columns extending from the sidewalk level to the third floor level. These granite columns are purely for architectural or ornamental purposes, and carry no load except their own weight.

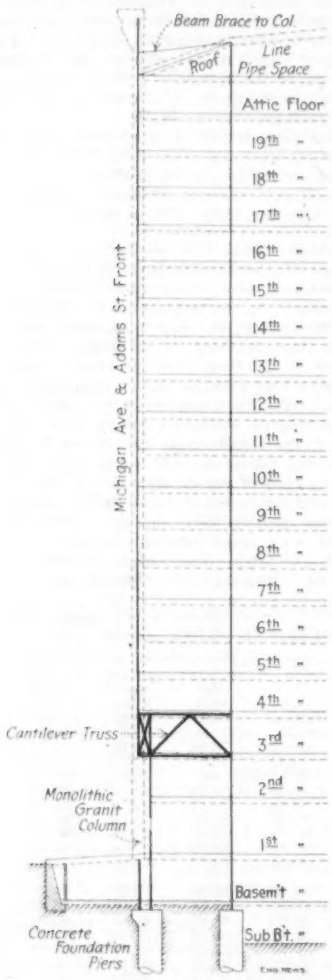



Fig. 1. Sectional Elevation of the Street Fronts of the People's Gas Light & Coke Co.'s Building, Chicago; Showing Cantilevered Support of Upper Floors.

(The front columns up to the fourth floor are set back 4 ft. 5 ins. from the front columns above the third floor.)

The total load at the fourth floor on the cantilever projection of the truss is 1,569,800 lbs. From the sectional elevation in Fig. 1 it will be seen that the upper portion of the inner front column is carried up to the fourth floor level (to the top of the truss), while the lower portion of the outer front column begins at the third floor level, being built into the truss. The shear between these two columns is taken up by two 15/16-in. plates, one on each side of the cantilever truss, of which these two columns form a part. These plates are riveted to the two sets of columns and are stiffened against buckling by angle iron stiffeners at short intervals. From the line of the inner column the cantilever truss extends back to the first interior column, where the upward reaction (amounting to 260,000 lbs.) is counteracted by the load on this interior column. The details of the truss and its connections are given in Fig. 2, which shows also the position of the granite columns.

The wind-bracing system in the fronts is carried down to the third floor level on the outer column and here transferred by horizontal bracing to the inner column, as shown in the third floor plan, Fig. 3. Through special wind-bracing girders, it is continued down to the foundation on the line of the inner column.

It is very important that this cantilever truss, on which so much depends, should be thoroughly fireproofed so as to guard against the possibility of its being reached by heat in case of a conflagration. For this purpose, each member of the truss is fireproofed separately; then solid tile walls are built outside of the fireproofed members, thus enveloping all of the members in a double system of fireproofing. This is indicated in Fig. 2.

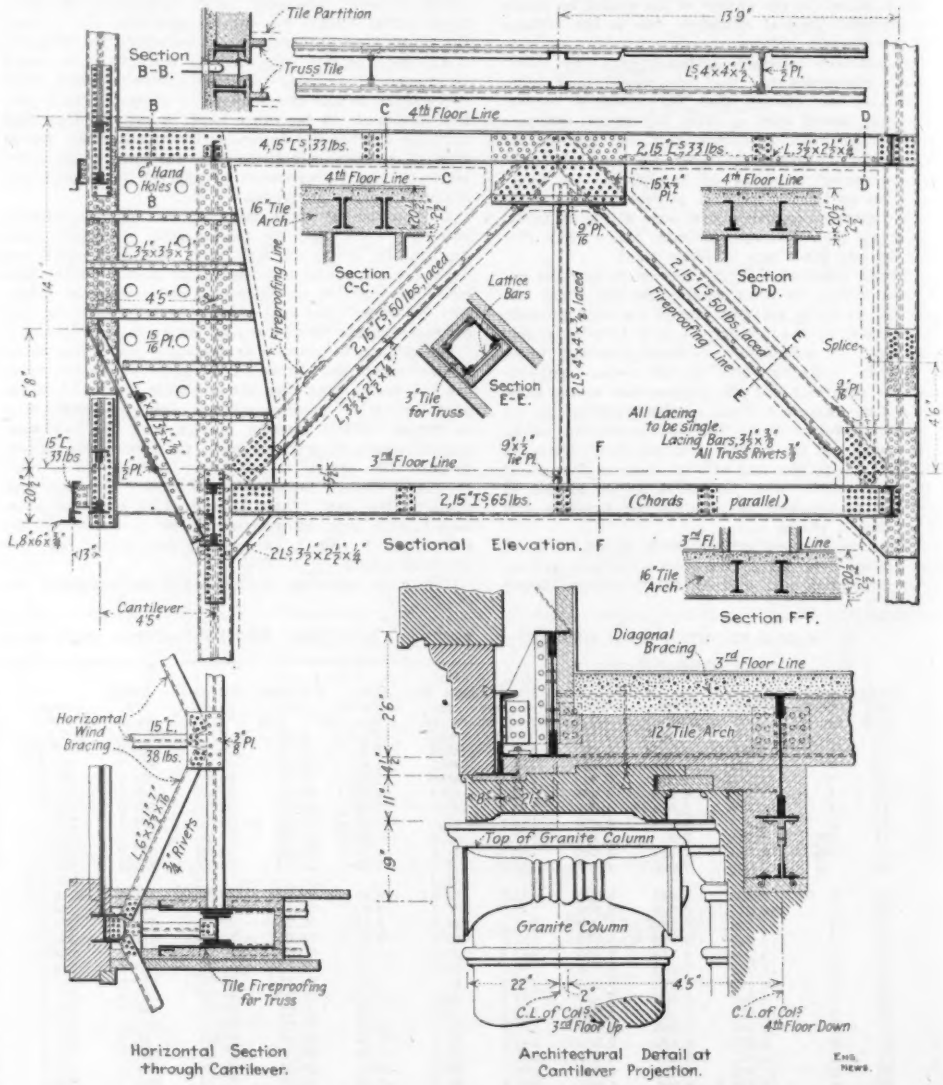


FIG. 2. DETAILS OF CANTILEVER TRUSS CARRYING UPPER PART OF FRONT OF BUILDING.

The entire wind resistance of the building is derived from spandrel girders of different depths, both in the outside and in the court spandrels. These spandrels in most cases have top and bottom brackets at the ends in order to increase their efficiency. The typical arrangement is shown in Fig. 4, and the details of the brackets are shown in Fig. 5. In most instances the floor arches are relied upon to transfer wind loads to these outer systems in either direction, but in cases where the floor is cut up by stairway and elevator openings a separate horizontal bracing is used. The typical arrangement of the wind bracing is shown in Fig. 4, and the details of the brackets are given in Fig. 5. The brackets of the inner columns are of gusset plates extending inside the girder webs and riveted to connection angles on the girders and columns. At the corners, t brackets are pairs of angles, instead of guss plates, with a more extensive spread. In t north wall, vertical diagonal bracing is used f the lower panels, as shown.

The building is covered with a sloping roof, an on account of the high cornice extending abo the low point of the roof, beams have been ru from the columns in the cornice to the high poi of the roof in order to brace the cornice and th tops of the columns. This is shown in Fig. 1.

The wind load for this building is figured a 30 lbs. per sq. ft. of exposed surface. The floo loads of the building are in accordance with th Chicago building ordinances: 50 lbs. for live loa and about 90 lbs. for dead load. The founda tions are the cylindrical concrete piers now gen erally used for deep foundations in Chicago, an are carried to hard pan at depths ranging from 80 ft. to 86 ft. below the inside grade.

The architects for the building are D. H. Burnham & Co., of Chicago, and for information as to the interesting structural features described above we are indebted to Mr. Joachim G. Giaver, M. W. S. E., Chief Structural Engineer in charge of the foundation and structural department of that firm. The contract for furnishing and erecting the steel work is held by the Lanquist & Illsley Co., which sublet the framing to the Morava Construction Co., both of Chicago.

A CIVIC CENTER FOR TOLEDO, OHIO, together with a monumental bridge and union railroad station and a number of parked avenues or boulevards, has been planned by Mr. E. O. Fallis, an architect of Toledo. Plans for these improvements were recently made public at a meeting held under the auspices of the Public Affairs Committee of the Business Men's Club of Toledo.

New Rules for Computing Train Resistance.

A new departure in methods of computing train resistance is set forth in a publication just issued by the American Locomotive Co. It has been well recognized for many years that different formulas should be used for the resistance of freight trains and of passenger trains. It has also been fairly well known that the resistance per ton of freight trains varies very considerably according to the capacity of the cars and whether they are empty or loaded. However, so long as nearly all the freight cars in service were from 40,000 to 60,000 lbs. capacity, it was not worth while to recognize the variation in the capacity of cars in computing train resistance. The rapid introduction of the 100,000-lb. freight car, however, and the surprisingly low resistance which it offers to traction, has made advisable a radical alteration in the methods of computing train resistance. The work of revising the standard formulas to suit present-day conditions has been undertaken by the American Locomotive Co.

Besides giving data for the resistance of cars of varying capacity both light and loaded, the Bulletin gives rules for computing the engine and tender resistance separately. The total friction of the engine, apart from the load carried on truck wheels and trailing wheels, is stated to equal the weight on the drivers in tons multiplied by 22.2 lbs. This resistance applies, of course, when the engine is working steam. When drifting with closed throttle the engine resistance may be largely in excess of this.

As most engineers interested in the subject of train resistance will wish to secure a copy of the Bulletin (No. 1001) containing these data, we take further space here only to reprint the summary at the close of the publication:

1. The resistance of freight cars varies greatly with their capacity, weight, and whether empty or loaded.
2. The decrease in resistance on level, straight track of 50-ton capacity cars (total about 72 tons) is of great significance in estimating tonnage ratings on low grade roads. This decrease in resistance becomes of gradually less importance with increase of grade.
3. The resistance of American freight cars is practically the same between the limits of 5-10 and 30-35 m.p.h.
4. Engine friction should be considered apart from the resistance of cars and estimated from the weight on drivers. The tender and part of engine supported on trucks or trailing wheels may be taken at the same resistance per ton as cars of approximate weight.
5. Engine friction may be approximated by multiplying the weight on drivers in tons by 22.2 pounds per ton.
6. Head air resistance may be estimated by multiplying the cross-sectional area in square feet by $.002V^2$
7. The resistance per degree of curvature in pounds per ton should not be taken at less than .08 for ordinary conditions. For locomotives it varies materially with the length of rigid wheel base.
8. The maximum horsepower of a locomotive is usually reached at about 700 ft. piston speed per minute; constant horsepower at 700 to 1,000, decreasing slightly at higher speeds with the decrease of efficiency of the engine.
9. The resistance of passenger trains has generally been overestimated, but the decrease in available power of locomotives at high speeds due to the decrease in mean effective pressure in combination with the energy absorbed in moving the engine and tender, has generally been underestimated.
10. Journal friction is greatest at starting, then rapidly decreasing and gradually reaching its minimum somewhere around 20 to 30 m.p.h., afterwards remaining constant or slightly increasing.
11. Journal friction with good lubrication, within the limits of railroad pressures, probably varies inversely as the square root of the pressure.
12. With large capacity loaded cars, at freight car speed on good track, journal friction forms a large percentage of the total resistance.
13. The condition of track, stiffness of rails, etc., are important factors in train resistance, because much energy is expended on poor track in dampened oscillations which cause an absorption of energy, and concussions which cause principally an increase in flange friction.
14. The segregation of the components of train resistance is very desirable, but much work remains to be done in analysis and experiments before satisfactory conclusions can be arrived at.

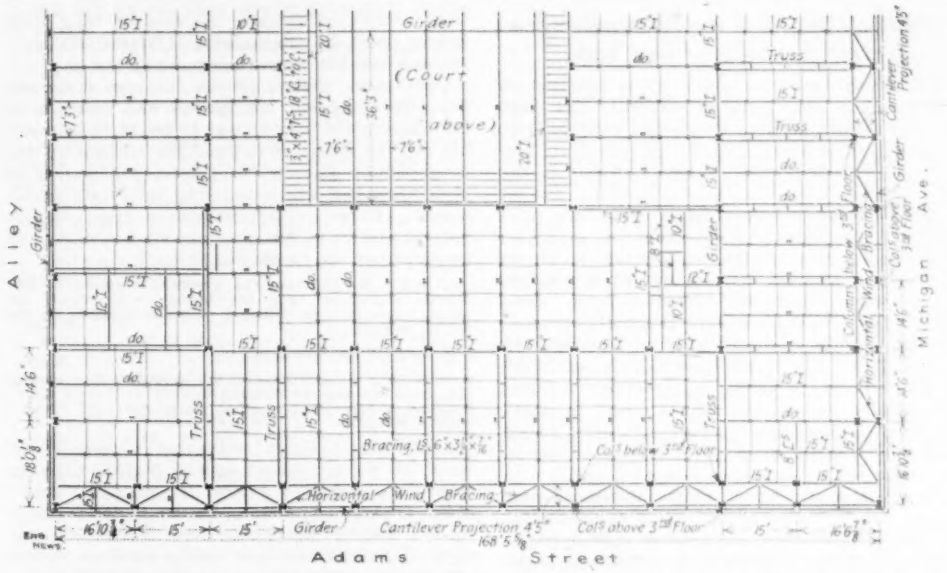


FIG. 3. PART PLAN OF FLOOR FRAMING AT THIRD FLOOR, SHOWING THE ARRANGEMENT OF THE CANTILEVER TRUSSES AND OF THE HORIZONTAL WIND BRACING IN THE CANTILEVER PANELS.

(This bracing transmits the wind stresses from the upper outer columns to the lower inner columns.)

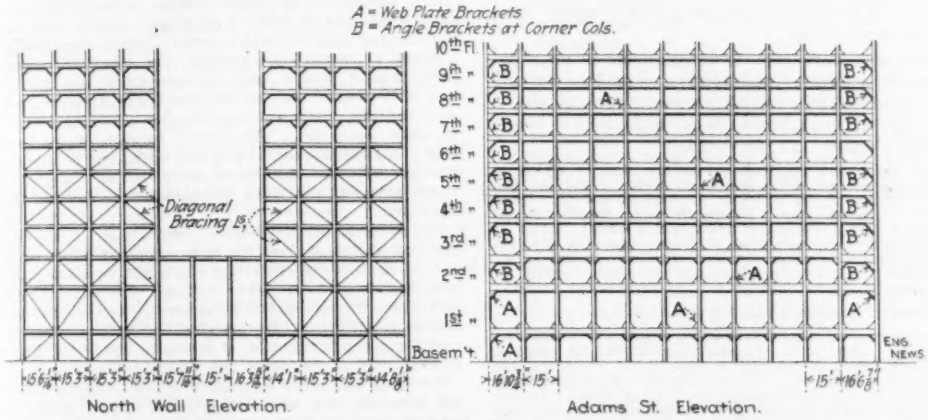


FIG. 4. TYPICAL ARRANGEMENT OF THE WIND BRACING SYSTEM, COMPRISING SPANDREL GIRDERS, BRACKETS AND VERTICAL DIAGONAL BRACING.

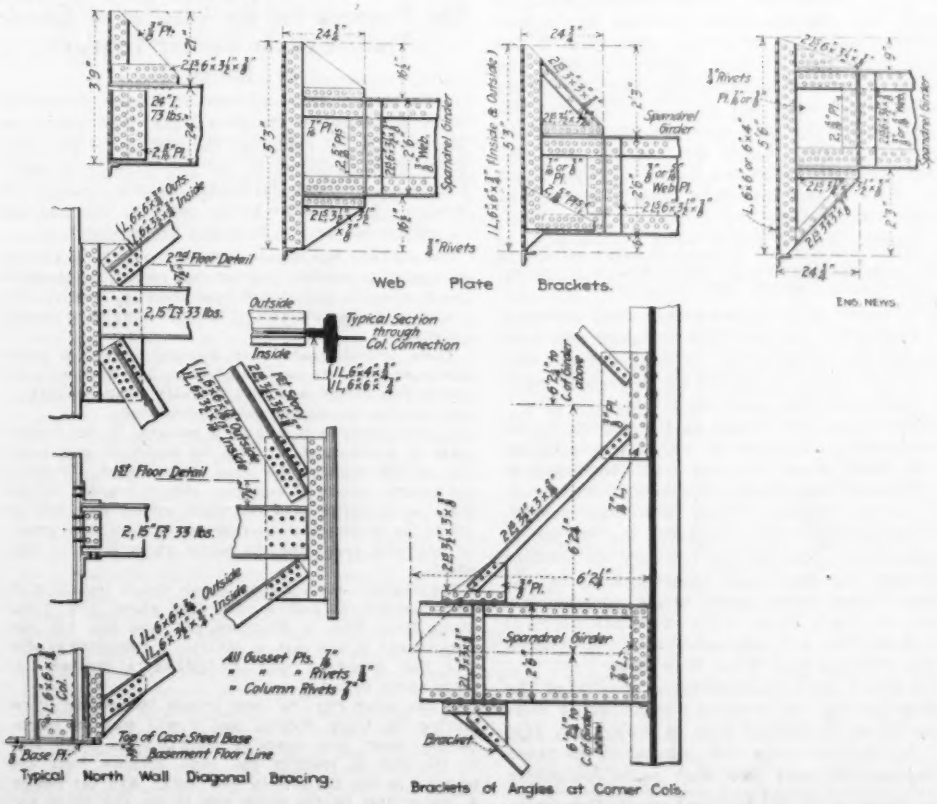


FIG. 5. DETAILS OF WIND BRACING.

Preliminary Report of the Metropolitan Sewerage Commission of New York.

For a number of years past there has been in existence, in one form or another, and with varying membership, a commission charged with the duty of investigating the pollution of New York Harbor and other waters adjacent to the City of New York and the metropolitan district in general. As reconstituted in 1908, this commission* consisted of Messrs. George A. Soper, President; James H. Fuertes, Secretary; H. de B. Parsons, Charles Sooysmith and Linsley R. Williams—all except Mr. Williams being members of the American Society of Civil Engineers. The life of this commission is to terminate on May 1, 1910. The commission has issued a preliminary report, in which it states that its final and detailed report will be completed in April, but that a preliminary report has been issued in order to facilitate possible legislative action this year.

The preliminary report is for the most part general in character, except for a recommendation that a permanent commission should be appointed, charged with the duty of making plans for sewage works according to the needs of the various natural drainage areas which comprise the metropolitan district as a whole. A joint commission, representing both the New York and New Jersey portions of the metropolitan district, is recommended, and, if an interstate commission is not feasible, then a commission representing that portion of the metropolitan district within New York is advised.

In its preliminary report the commission states that it has attempted (1) to gather information regarding the discharge of sewage into the waters surrounding the metropolitan district; (2) "to determine the extent to which these conditions were injurious to the public health and welfare;" and (3) to learn how necessary improvements for the present and future might best be made. Thousands of analyses of water and of mud deposits from the waters studied have been made, tidal phenomena studied, and estimates of future population and sewage discharge made.

The commission is of the opinion that the increasing pollution of the harbor demands immediate remedial measures. It states that the waters now receiving sewage are already becoming overburdened with these wastes; that bathing in the harbor above the Narrows is dangerous to health; and that the oyster industry in the harbor must soon be given up. The commission states that the Passaic, Rahway, Bronx and Harlem rivers and Gowanus and Newtown creeks "have become little less than open sewers." It is also stated that the water in the main channels of the harbor above the Narrows, and also in both the East and Hudson rivers, "is more polluted than considerations of public health and welfare should allow," and that

> the digestive capacity of this water for sewage is so reduced by pollution that restrictions should at once be placed upon the discharge of sewage therein to prevent the harbor from becoming positively offensive.

In addition, it is asserted that tidal currents, on which stress has been laid by many who have discussed the subject, "do not flush out the harbor satisfactorily, but cause the sewage to oscillate back and forth near its points of origin."

Reference is then made in the report to the existing joint outlet sewer which serves 37 sq. mi. of New Jersey territory and discharges at Elizabethport opposite the Borough of Richmond; also to the Passaic Valley sewerage project, which as proposed will discharge the sewage of 103 sq. mi. of New Jersey territory at Robbins Reef near the Statue of Liberty; and to the Bronx Valley sewer, now under construction, which will drain 35 sq. mi. of territory north of New York City and discharge into the Hudson at the Yonkers-New York City line.

It is stated that the combined capacity of the existing and the two proposed trunk outlet sewers would be 700,000,000 gals. of sewage per day, and that by the time the population in these trunk-sewer districts was such as to contribute that volume of sewage the city of New York would itself be discharging 1,000,000,000 gals. per day into the waters surrounding the city.

The report then proceeds, on the catechism plan, to bring out conclusions and opinions of the commission, as follows: It would be impossible for the eighty municipalities making up the metropolitan district "to protect the waters of New York Bay and vicinity by interstate agreement." Large collecting sewers from various natural drainage districts should be built, and these should be accompanied by

> local works for purifying the sewage to a greater or less degree, depending upon the facility with which the effluent can then be disposed of without injury to the public welfare.

Means of purification

> most worthy of consideration are sedimentation, screening, filtration and sterilization applied with such modifications as experience in other places and local circumstances indicate.

A sewerage district embracing a territory of some 700 sq. mi., about equally divided between New York and New Jersey, is considered desirable. If such a two-state district is not feasible, then a district comprising New York City and parts of Nassau and Westchester counties should be created. Administrative control in either case should be vested in a sewerage commission. It is considered probable that at the present time it would be more feasible to create two districts and two commissions, one for each state, formed to act in harmony, than to secure a single interstate commission.

The first duty of a joint commission, or of the possible separate commissions, would be to utilize information already gathered for the carrying out of recommendations made in the report under review. To this end,

> there should be prepared an outline plan to which all future sewerage work should conform so far as that work relates to the ultimate disposal of sewage. There should also be plans, drawn in some detail, for the disposal of the sewage of individual districts, beginning with those where the need for improvement is greatest. This program involves for the immediate future no expenditure or commitment of city or state beyond the expenses of the commission for the preparation of plans.

Finally, the commission states:

> In conclusion, the Metropolitan Sewerage Commission desires to state with all possible clearness its sense of the importance of putting a stop to the unrelated and unsanitary methods of sewage disposal which are being followed in the metropolitan territory of New York and New Jersey and to urge that prompt action be taken to establish an effective system of conservancy to protect and improve the condition of the harbor.

*The address of the Metropolitan Sewerage Commission of New York is 17 Battery Place, New York City.

The Prospects for the Adoption of Electric Traction on the Railway Terminals at Boston.

In a recent public address at Boston, President Chas. S. Meller of the New York, New Haven & Hartford R. R., explained the position of his company with reference to the introduction of electricity on railway terminals in the vicinity of Boston. We reprint below parts of his address as published in the Boston "Transcript:"

Our company has already invested a very large amount of capital in electric traction, as applied to standard steam railroads, and is still experimenting, largely, with a view to the improvement of the system we have already installed.

These improvements have already reached a stage where we know we can again accomplish what we have for far less money, and with probably greater efficiency, and our experiments are not yet concluded.

In our judgment it will be a mistake, in the present stage of development, to force, by legislative enactment, the electrification of the lines about Boston. Through the natural process of evolution, electric traction will be installed in Boston, and the whole subject may well be left to the managers of the railroads as those more greatly interested even than the public which is to be benefited.

The situation about Boston is one that is fraught with much greater difficulties than that about New York. From New York to Stamford our line has but one branch, and it was easy to electrify a straightaway line like that compared with electrifying a similar distance about Boston.

In the latter city the lines branch immediately upon leaving the Union Station, and it will cost, in consequence, about four times as much on the south side of the city to electrify the same distance from the terminal as was the case in New York. And the Boston & Maine lines on the north side of the city could not be electrified for a less sum.

Thus you see the problem is one of immensely greater importance from a capital standpoint in Boston than in New York, and it should not be entered upon too hastily nor until after the experiments we are now making on our present lines are completed.

Our electrification between the Grand Central Station and Stamford is working very satisfactorily. There are probably less interruptions to our service between these points than when operated by steam, and, of course, the comfort of the passengers is promoted to a very great extent and the service has become very popular.

For my own part I do not see how the railroads about Boston can be expected to substitute electricity for steam, without there is an increased toll collected. A very large proportion of commutation or suburban service is unprofitable at present rates, and unless the substitution of electricity for steam is going to increase it tremendously, and beyond what is our experience on the west end of our road, I do not see where the business is coming from that will warrant the expense.

So far as we have gone upon the west end of our road we have not yet been able to definitely determine there is any saving whatsoever in the use of electricity as compared with steam. If there is a saving it is so small as not to have made itself manifest in our accounts up to the present time.

It is inadmissible that electrification of a standard railroad be considered until all grade crossings are eliminated, and the situation in and about Boston leaves much yet to be accomplished in this respect.

No company has done so much in the way of applying electricity to railroad operation as has the New Haven, and it would be a great mistake to force a situation by legislation upon a company admittedly so far in advance of all others in what it has already accomplished, and in what it is at the present time endeavoring to learn through a series of costly experiments.

Asked to name some specific time when the steam roads around Boston would be electrified, Mr. Meller said if the tunnel between the North and South stations goes through, work on electrification could be started in about two years. The tunnel, he said, is the first step to all improvements; it is the initial step in electrification. However, nothing is being lost by the present delay, as much was being accomplished in studying the situation.

The policy of the New Haven road is based on the belief that the main lines for both passenger and freight will be operated by electricity. This will necessitate the construction of large power houses. The one at New Haven will furnish 50,000 horsepower. As the full-load periods would be in the morning and early evening it would mean a great deal of available power for other purposes during the larger part of the day and night.

We could sell power to traction systems and for lighting purposes, and we could sell our surplus power to manufacturers along the line of the road.

Notes from Engineering Schools.

UNIVERSITY OF KANSAS.—The new engineering buildings were formally dedicated Feb. 25. About 500 visitors, including alumni, engineers from other schools and other interested persons, were present at the dedicatory exercises. The program comprised three addresses in the chapel in the afternoon, the dedication ceremony itself held a little later in the new mechanical and electrical engineering building and a banquet at the Robinson gymnasium in the evening. The addresses in the chapel were made by Prof. F. O. Marvin, M. Am. Soc. C. E., Dean of the School of Engineering; Prof. Richard C. Maclaurin, President of the Massachusetts Institute of Technology, and Mr. Ernest R. Buckley, M. Am. Inst. M. E., President of the American Mining Congress.

DARTMOUTH COLLEGE.—A spectacular fire at 2.30 a. m. Feb. 26 destroyed the dormitory known as South Fayerweather Hall. About 50 students were in bed in the dormitory when the fire started, and a number of these made their escape by jumping or lowering themselves with improvised ropes from the windows. No one was seriously injured, although there was some suffering due to the temperature, which was several degrees below zero. South Fayerweather Hall was a four-story brick structure built about two years ago. The flames started in the basement and the entire building was gutted within half an hour, leaving only the brick walls. The fire was discovered by the night watchmen, who sounded the alarm which roused the students. The cost of the building was about $35,000 and the students' personal effects lost in the fire brought that total up to about $60,000.

AN EXPLOSION AT ROBY, IND., at the works of the American Maize Products Co., March 7, killed eight persons and injured 17 others. The accident is ascribed to the overheating of a starch kiln.

THE COLORADO RIVER, according to press despatches, is building a sand bar in front of the headgate of the main irrigation canal of the California Development Co. It is stated that this sand bar threatens to cut off the irrigation water-supply of the Imperial Valley, and that application has been made to the Secretary of War for permission to build a diverting dam to maintain the flow of water to the canal.

A POWDER MAGAZINE IN A GOLD MINE exploded March 2 shortly before midnight in the Mexican shaft of the Treadwell gold mines, on Douglass Island, near Juneau, Alaska. Within 30 ft. of the magazine a group of miners was assembled waiting for the cage to take them to the surface and 31 of them were killed outright while two died later from injuries. The magazine contained about 275 lbs. of powder. The Treadwell mine is one of the largest gold mines in the world and employs about 1,400 men.

AN ELEVATOR ACCIDENT in the Nassau-Beekman office building at 140 Nassau St., New York City, March 3, is ascribed by unconfirmed press reports to interference of the counterweights of two adjacent elevators. The counterweights of three elevators were arranged close together in the central shaft. One of them, according to the report, left its guide and struck one of the others in passing. The sheave strap of the ascending counterweight of the two was pulled apart by the sudden extra load put upon it and the corresponding car, which was of course descending, was left unbalanced and dropped 30 ft. to the bottom of the shaft. Six of the ten persons in the elevator were injured, one very seriously. Owing to the short fall the safety clutches did not have time to stop the car.

A NUMBER OF AVALANCHES IN THE NORTHwest have followed upon those noted in our last week's issue, due to the excessive accumulations of snow in the mountains, coupled with unseasonably warm winds. The most disastrous of the snow slides since the one at Wellington at the mouth of the Cascade Tunnel on March 1, occurred at Rogers Pass, B. C., March 5. A party of track laborers on the Canadian Pacific Ry. were at work removing the debris of a small slide at that place when they were overwhelmed by a second and larger avalanche which buried 60 men and a rotary snow plow. A relief train with 200 persons on board was quickly sent to Rogers Pass from Revelstoke, and reports of March 7 announced that 36 bodies had been recovered and that traffic would be resumed March 8. Reports of the same date say that the relief train with 200 persons was buried by another slide on its return trip to Revelstoke, but that there was in this case no loss of life. Another Canadian Pacific passenger train barely missed being struck by a large snow slide March 5 near Field, B. C. The train was stalled in Field.

In the avalanche at the west end of the Great Northern's Cascade Tunnel in central Washington, the number of persons killed is now placed at 84. On March 7, the number of bodies already recovered was given as 50. The wrecked trains were carried some distance down the slope and buried under about fifty feet of snow and debris. Large uprooted trees in the avalanche added to the difficulty of digging out the cars. The track is blocked in both directions from the tunnel so that no wrecking cranes can be brought to the scene.

Many other less serious slides have been reported. In all cases the breaking of the telegraph lines by the snow slides makes it difficult to get news of them.

FLOODS AND ICE JAMS are reported in various parts of the country as the result of warmer weather and local rains. The worst troubles reported are in the valleys of the Mohawk and Hudson Rivers in New York. Ice jams in the Mohawk near Fort Plain, a small town about 50 miles west of Albany, flooded the towns of Ilion, Frankfort and Herkimer on Feb. 27. For several days the principal streets and stores in these towns were flooded, power-houses were put out of commission and the manufacturing plants in the vicinity were forced to close. On March 2, a narrow channel was dynamited through the ice gorges of the Mohawk and the waters began to fall. This work was done by four separate gangs, employed by the state and local departments of public works and by the New York Central and Mohawk Valley railroads, respectively.

An ice jam started in the Hudson River about 12 miles below Albany on March 1, and by March 3 a solid mass, filling the bed of the river and piled high in the air, extended from New Baltimore to Castleton, a distance of eight miles. Two heavy steel boats were sent up from Rondout to clear the river below the jam, which was being dynamited by employees of the State Department of Public Works. On March 7 the gorge was cleared and the two boats mentioned opened a channel to Albany.

Throughout Ohio similar floods and jams were reported during the week, though they were less threatening. The Maumee River was at the highest stage since 1883 and bridges were threatened at Fort Wayne. The Ohio did not reach a dangerous point. At Zanesville, Fremont, Sandusky and Coshocton several hundred houses were flooded, while at Youngstown several manufacturing plants had to be closed.

Washouts are reported along the railroads in Washington, Oregon, Utah and Nevada, so that transportation is blocked at many points. Damage to irrigation works in southern Idaho has also been reported though the accounts are indefinite.

FROM THE ST. PAUL MINE AT CHERRY, ILL., 61 bodies of victims of the fire last November were recovered March 4. The bodies are described as being in a mummified condition, but could not be identified.

A TUNNEL BENEATH THE CITY OF BOSTON to connect the North and South stations will be built by the New York, New Haven & Hartford R. R. whenever satisfactory legislation can be secured.

In a recent public address at Boston, President Mellen said: "If a charter is given for a tunnel, upon terms that the company can accept, it will be disposed to construct the same at the earliest opportunity." He declared, however, that the company would only accept a perpetual charter for the tunnel and that it would probably charge a toll or a fixed amount per passenger for the use of the tunnel.

A BROAD STREET SUBWAY IN PHILADELPHIA is again being brought actively to the front, and the local situation makes it not improbable that a franchise for the line will be granted. The project is put forward by private parties, and involves no municipal cooperation or aid. It comprises a subway north and south on Broad St., extending north to York St., about 2 mi. north of Market St., and from this point radially outward three elevated-railway feeders, running respectively 2 mi. northwest to Strawberry Mansion (in Fairmount Park), 3 mi. north to Wayne Junction, and 3 mi. northeast to Frankford.

SAFETY APPLIANCES FOR RAILWAY TRAINMEN on freight cars are to be made uniform on all cars after July 1, 1911. In the report of the Chief Inspector of Safety Appliances dated Nov. 13, 1908, the Chief Inspector said:

Most valuable safety-appliance legislation would be that which would establish and require uniformity of location and application of ladders, sill steps, hand holds, and kindred appliances. This standardizing should, by all tokens, be inflexibly established, as it is the one thing needful above all others to preserve trainmen from bodily harm. The Master Car Builders' Association through its "standard and recommended practice" recognizes this principle, and legislation to the same effect, but which could be more comprehensive, would be a recognition of the wisdom of that association in attempting to secure absolute uniformity of location of those appliances.

An act has passed both houses of Congress, which puts into effect the recommendations of the Inspector and sets forth that all cars must be equipped with secure sill steps and efficient hand brakes, and that all cars requiring ladders and running boards shall be so equipped and shall have secure hand holds or grab irons on the roofs. The Interstate Commerce Commission is to formulate, after notice and hearing, rules for the uniform position and size of such safety appliances.

AN APARTMENT HOUSE FIRE in New York City on March 4 contained several noteworthy features. The building contains very high-priced apartments, is 12 stories high, about 100 ft. square in ground-plan, and was built last year, but up to now has been only partly occupied. A tenant on the tenth floor rented also the apartment below, on the ninth floor, and was having a connecting stairway put in. Fire started in the apartment on the ninth floor, and apparently found enough combustible material to gain good headway before it was discovered. The flames broke out through the windows facing on a closed inner court, and beat up into the windows on the floor above, and successively upward to the top story. The fire was hard to fight because of its height but spread no further. Very extensive water damage was done on all the floors below, however. The floor construction was cinder-concrete slab, with fill and wooden surfacing. It is stated that the water leaked through the floors freely, and that while no water ran down the stairway, yet water found its way down as far as the first floor, doing extensive damage to plastering, furniture, etc. Besides this permeability of the floors, the following facts appeared: The unprotected windows facing on the court, having wood frames and sash and plain glass, made it easy for the fire to pass from one floor to the one above. Metal or metal-covered frames and sash or fire shutters are not required. The elevator shaft and stair well were cut off by fire-walls and metal doors (although metal doors are not required by the present building law), and the fire did not communicate upward by this route. However, the partitions in the building, which were 3-in. block partitions, showed very poor resistance, and in fact failed. There partitions had no reinforcing studding. Further, the flange-protection of the I-beams of the floor, which consisted merely of wire mesh covered with plaster, failed extensively, and had the fire been at all hot the floor framework would no doubt have been seriously affected.

A BASE-BALL PARK UNDER CONSTRUCTION at Chicago is to have stands accommodating 35,000, built of reinforced concrete, and the total outlay is said to approach half a million dollars.

A HIGH-PRESSURE FIRE SERVICE for Boston, to take water by pumping from the Charles River Basin, is proposed by a bill now before the Massachusetts Legislature. A hearing on the bill will be held on March 11.

HYDRAULIC MINING OPERATIONS in the Great Valley of California, prior to the time they were stopped by the Courts, carried over 300,000,000 cu. yds. of debris into the Yuba River, according to the estimates of the U. S. Geological Survey.

ENLARGEMENT OF THE WELLAND CANAL is to be urged by the Great Lakes & St. Lawrence Improvement Association, under the leadership of the Toronto Board of Trade. An appropriation of $2,000,000 is urged at the present session of Parliament, and an entire expenditure of $20,000,000.

A "CHICAGO BEAUTIFUL" COMMISSION, consisting of 325 members, with Mr. Charles H. Wacker as Chairman, has been appointed by Mayor Busse. The duty of the commission is to further the elaborate plans recently worked up by and in behalf of the Commercial Club of Chicago for a civic center and other notable improvements on the water front and elsewhere in Chicago.

THE ILLINOIS RIVER DEEP WATERWAY scheme under which the State proposed to spend $20,000,000 to give deep water for navigation and create water power, was turned down, by the special session of the Illinois legislature which adjourned on March 2. The bills proposing to go ahead with the construction of the deep waterway were defeated and it is stated that public sentiment has turned against the project in the last few months.

THREE SEWAGE PURIFICATION PLANTS for Atlanta, Ga., with trunk sewers leading thereto, were authorized recently at a bond election held in that city. The plants will be located on the outskirts of the city, each one, of course, serving a natural drainage district. Bonds to the amount of $1,350,000 have been authorized. Mr. R. M. Clayton, M. Am. Soc. C. E., is City Engineer of Atlanta, and Mr. Rudolph Hering, M. Am. Soc. C. E., of New York City, is Consulting Engineer for the sewerage and sewage disposal work.

"SEWAGE INTO SUGAR" is the somewhat sensational title of a paper by Mr. J. Ashton, read before the British Association of Managers of Sewage Disposal Works in January, 1910. What Mr. Ashton really advocated was the raising of sugar beets on sewage farms. After reviewing the drawbacks to the production of milk, the raising of basket willow, potatoes and turnips, and stating the fact that the mangel-wurzel seems to be the best crop for sewage farms, the author remarked that even this crop does not pay very well "unless the farm is situate near a large town where large milk stocks are kept in the immediate neighborhood." The author then suggests that sewage farms that will grow mangel-wurzels will certainly be suitable to sugar beets, which are of the same family, require rich soil, and "can stand any amount of sewage . . . provided the land is perfectly porous" and good drainage is provided. The author stated that in an experimental way he had had success with raising sugar beets and that a crop of 43 gross tons per acre had been raised on the Liverpool sewage farm. In the course of the paper it was suggested that if cultivation of the sugar beet was taken up earnestly in England, by means of cross fertilization and careful selection better results could be obtained than could now be had in England with foreign seed. Mr. Ashton continued:

Then my advice to all sewage farm managers is to put down at least one pound of sugar beet seed each year, under what he considers the best conditions on his farm; he need not be afraid of doing this at a loss, and especially so if he grows mangolds, because one ton of sugar beet is equal in nutritive value to one and a half tons mangolds; and let us meet here at the end of each year for one night's discussion on the results obtained, and thus help to develop an industry which ought to be one of our leading agricultural pursuits, creating a manufacturing trade which should be second to none, finding labor in all branches of trade

connected with the industry for hundreds of thousands of hands all over the country, for we import nearly 2,000,000 tons of sugar every year.

Would it pay to put down a small plant for, say, dealing with 1,000 tons of beet during one term? If a small plant could be put down at a moderate cost, probably some energetic corporation that possesses a large sewage farm might be induced to enter into the manufacture of its own sugar from beets grown by the aid of the sewage from its own population, thereby adding another link towards that beautiful cycle of nature so necessary for the prosperity of our nation, and hence "Sewage into Sugar."

Mr. Ashton's recommendations were concurred in by a Mr. Stein, who was brought forward as a beet-sugar expert to discuss the paper; but Mr. Stein qualified his remarks with the statement that it would be impossible to erect a small sugar plant for less than about $50,000 for machinery alone. At the same time he remarked that in Belgium the beet roots were pulped at small plants, and further treatment was carried out at a central factory. This plan, or a modification of it, might be possible in connection with sewage farms. Mr. Stein said that of 4,000 experiments which he had made in the cultivation of sugar beets in the United Kingdom, the most successful had been those conducted on sewage farms. Crops of from 18 to 41 gross tons per acre have been produced on sewage farms, and an analysis of the beets gave satisfactory results. They showed an average of 16% of sugar. His figures are better for gross yield than, and approximately the same for sugar percentage as, results achieved in Germany.

Personals.

Mr. H. H. Tracy has been appointed City Engineer of Norfolk, Neb.

Mr. R. S. Lea, M. Am. Soc. C. E., and M. Can. Soc. C. E., has been elected a member of the British Institution of Civil Engineers.

Mr. Milton Freeman has been made Superintendent of the Lake Shore Electric Ry. He was formerly Trainmaster of the same line.

Mr. D. A. Daly, an assistant engineer of the Northern Pacific Ry. at Mandan, N. Dak., has resigned to take a position with the firm of Johnson & Carey, contractors, of that place.

Mr. Clemens Herschel, M. Am. Soc. C. E., was married March 5 at Springfield, Mass., to Miss Jeannette B. Hunter, recently a resident of New York City. After a trip south, Mr. and Mrs. Herschel will reside at his home in Glen Ridge, N. J.

Mr. Herman K. Higgins, Assoc. M. Am. Soc. C. E., recently Assistant Engineer of the Isthmian Canal Commission at Gatun, Canal Zone, Panama, has reestablished himself as a consulting engineer in Boston, Mass., with headquarters at 53 State St.

Mr. R. L. Murphy, Assoc. M. Am. Soc. C. E., has resigned his position as District Sales Manager for the Corrugated Bar Co., at St. Louis, Mo., and is now Treasurer of the Murphy Construction Co., general contractors, of East St. Louis, Ill.

Mr. Alexander Shaw, Superintendent of the Berkshire Street Ry. at Pittsfield, Mass., has been appointed Superintendent of the Pittsfield Electric Street Ry. in charge of all lines south of Cheshire, Mass. Mr. S. B. Bradshaw has been appointed Master Mechanic of the Pittsfield Electric Street Ry.

Mr. F. E. Whitcomb has been appointed Engineer of Signals of the Boston & Albany R. R. at Boston, Mass., to succeed Mr. J. M. Fitzgerald, whose appointment as Assistant Signal Engineer of the New York Central & Hudson River R. R. at Albany, N. Y., was noted in this column last week.

Mr. David Sloan, M. Am. Soc. C. E., Chief Engineer of MacArthur Bros. Co., contractors, of Chicago, Ill., has been made Consulting Engineer. Mr. W. G. Sloan, M. Am. Soc. C. E., hitherto Eastern Manager of the same company in New York City, has been appointed Chief Engineer to succeed Mr. David Sloan.

Mr. George A. Ricker, M. Am. Soc. C. E., and Mr. George S. Minniss, Assoc. M. Am. Soc. C. E., have formed the firm of Ricker & Minniss, engineers, with offices in Ellicott Square, Buffalo, N. Y. In addition to carrying on the practice established by Mr. Ricker, the firm will continue the work of the Buffalo Testing Laboratory.

Mr. Charles H. West, M. Am. Soc. C. E., has been appointed a member of the U. S. Mississippi River Commission to fill the vacancy created by the death of Mr. H. B. Richardson, M. Am. Soc. C. E. Mr. West has resigned his position as Chief Engineer of the Mississippi Levee District and Mr. W. J. Shackelford has been appointed to succeed him.

Mr. Lewis Kingman, M. Am. Soc. C. E., Assistant Chief Engineer of the National Railways of Mexico, has been appointed Engineer of Maintenance of Way, with headquarters at Buenavista, to succeed Mr. C. G. Delo, resigned. Mr. H. B. Reese, formerly District Engineer at Chihuahua, has been appointed to succeed Mr. Kingman as Assistant Chief Engineer.

Mr. Lewis E. Ashbaugh, formerly Office Engineer of the Central Colorado Power Co., at Denver, Colo., is now Hydraulic Engineer in the San Francisco office of J. G. White & Co. It was announced in this column Feb. 3 that Mr. Ashbaugh had been appointed Assistant Chief Engineer of the Los Angeles, Cal., highway project. It has since been learned that while Mr. Ashbaugh was offered this position he did not accept it.

Mr. P. H. Houlahan has resigned his position as General Manager of the Chicago & Alton R. R. and the Toledo, St. Louis & Western R. R., effective March 15, and will retire from active service. Mr. A. H. Westfall has been appointed General Superintendent of both roads, with headquarters at Bloomington, Ill., and the position of general manager has been abolished. Mr. Westfall was formerly General Superintendent of the Southern Ry. at Greensboro, N. C.

Mr. W. C. Smith, Engineer of Maintenance of Way of lines east of Paradise of the Northern Pacific Ry., has been promoted to be Chief Engineer of Maintenance of Way with jurisdiction over the entire Northern Pacific system. In our issue of Feb. 24 it was erroneously said that Mr. Wm. C. Smith, M. Am. Soc. C. E., had been appointed to the new position with the Northern Pacific. Mr. Wm. C. Smith, M. Am. Soc. C. E., is still Chief Engineer of the Idaho & Washington Northern R. R., at Spirit Lake, Idaho.

Maj. Jay J. Morrow, Corps of Engineers, U. S. Army, has been relieved of duty in charge of the water-supply system of the District of Columbia and the improvement of the Potomac River and has been ordered to Portland, Ore., for duty in charge of river and harbor improvements in the Northern Pacific division. He will relieve Maj. James F. McIndoe, Corps of Engineers, of part of his present duties. Maj. Morrow will be relieved temporarily at Washington by Capt. W. T. Hannum, Corps of Engineers. Capt. Hannum graduated at West Point in June, 1902, and was made a captain in December, 1909.

Obituary.

Richard C. Oliphant, President of the Trenton Malleable Iron Co., died March 4 at his home in Trenton, N. J. He was born in Uniontown, Pa., in 1852.

David P. Cameron, Vice-President and Superintendent of the Western Engineering & Construction Co., died Feb. 24 at his home in San Francisco, Cal., at the age of 65 years.

Allen T. Scovill, formerly Track Superintendent of the Alton, Granite & St. Louis Traction Co., died Feb. 23 at Alton, Ill., aged 65 years. He had been in the service of this same company in various capacities for 40 years.

Charles F. Aaron, Past-President of the American Supply and Machinery Manufacturers' Association, died March 4 at his home in Plainfield, N. J. Mr. Aaron was General Sales Manager of the New York Leather Belting Co.

Charles L. Gilpatrick, Assistant Superintendent of the Boston terminal division of the Boston & Maine R. R., died Feb. 28 at his home in Somerville, Mass. Mr. Gilpatrick was born at Limington, Me., in 1856. He entered the service of the Boston & Maine R. R. as a brakeman and was promoted through the various grades becoming an assistant superintendent in 1894.

Edward W. Very, a consulting ordnance engineer, died March 1 at his home in New York City aged about 60 years. He entered the U. S. Navy as a midshipman in 1863 and later saw service in both European and Asiatic waters and ports. He resigned from the navy in 1885 and became connected as an ordnance expert with the Hotchkiss interests. His headquarters in this capacity were for many years in Paris and he made numerous visits to China, Turkey and other countries contemplating the acquisition of new armament and arsenals. He later became Vice-President of the American Ordnance Co., which eventually proved unsuccessful. Mr. Very had since practised as a consulting engineer. He was the inventor of the Very night signal and other devices used in the navy.

Engineering Societies.

COMING MEETINGS.

AMERICAN RAILWAY ENGINEERING AND MAINTENANCE OF WAY ASSOCIATION.
March 15-17. Annual convention at Chicago, Ill. Secy., E. H. Fritch, 962 Monadnock Block, Chicago, Ill.

AMERICAN WATER WORKS ASSOCIATION.
April 26-30. Annual convention at New Orleans, La. Secy., J. M. Diven, 14 George St., Charleston, S. C.

AMERICAN ELECTROCHEMICAL SOCIETY.
May 5-7. Annual meeting at Pittsburg, Pa. Secy., Jos. W. Richards, South Bethlehem, Pa.

APPALACHIAN ENGINEERING ASSOCIATION.
May 6-7. Annual meeting at Winston-Salem, N. C. Secy., Henry M. Payne, Morgantown, W. Va.

AIR BRAKE ASSOCIATION.
May 10. Annual meeting at Indianapolis, Ind. Secy., F. M. Nellis, 53 State St., Boston, Mass.

AERO CLUB OF AMERICA.—This organization has recently secured one of the few remaining suites of offices in the United Engineering Societies' Building, 29 West 39th St., New York City.

AMERICAN SUPPLY AND MACHINERY MANUFACTURERS' ASSOCIATION.—The annual convention will be held at Jacksonville, Fla., April 5-7 in cooperation with the Southern Supply and Machinery Dealers' Association.

CANADIAN SOCIETY OF CIVIL ENGINEERS.—At the regular meeting at Montreal, March 3, an address on 'The Conservation Problem as Applied to Canada' was delivered by Mr. C. R. Coutlee. The presentation of the Gzowski Medal for 1909 took place at this meeting.

NATIONAL ASSOCIATION OF COTTON MANUFACTURERS.—The 88th annual meeting will be held at Boston, Mass., April 27-28. The sessions will be held in the Mechanics' Fair Building in conjunction with the Textile Exhibitors' Association's exhibit of textile machinery.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—At the meeting held in New York City March 2, a paper on "The Improved Water and Sewage Works of Columbus, Ohio," by John H. Gregory, was presented for discussion. This paper was printed in the "Proceedings" for January, 1910.

CANADIAN MINING INSTITUTE.—The twelfth annual convention was held in Toronto, Ont., March 2-4. Among the papers presented were the following: "The Clays of Nova Scotia," Heinrich Ries, Cornell University; "Mining in the Megantic Region of Quebec," Dr. James Douglas, New York City; "The Concentration of Cobalt Ores," Robt. H. Richards, Massachusetts Institute of Technology. Other papers were contributed by F. L. Ransome, Washington, D. C.; J. D. Irving, New Haven, Conn.; Benjamin B. Lawrence, New York City; J. D. Kendall, London, England; and Allan Greenwall, editor of the English "Colliery Guardian."

A smoking concert on Wednesday, March 2, and the annual banquet Friday evening, comprised the chief social features of the convention.

AMERICAN WATER WORKS ASSOCIATION.—At the 30th annual convention in New Orleans, April 26-30, an informal social session on Tuesday evening, April 26, will replace the customary formal reception. At this session, Mr. Geo. G. Earl will give an illustrated lecture on the New Orleans sewerage and water-supply systems. The lecture will be followed by refreshments and dancing. The morning and afternoon sessions on Tuesday, the morning sessions on Wednesday and Thursday, and the morning, afternoon and evening sessions on Friday, will be devoted to the transactions of business and the reading and discussion of papers. The afternoon and evening on Wednesday and Thursday will be taken up with entertainments and excursions.

The exhibits will be in charge of the Water Works Manufacturers' Association, Secretary, R. E. Milligan, 15 Broad St., New York City, which has also taken over the management of the entertainment features of the convention, including an excursion to the recently completed water-works and sewage disposal plants of New Orleans.

INDIANA SANITARY AND WATER-SUPPLY ASSOCIATION.—At the annual meeting at Indianapolis, Ind., Feb. 25-26, officers were elected as follows: President, H. E. Barnard; Vice-Presidents, D. R. Gwinn of Terre Haute, H. A. Dill of Richmond, J. B. Marvin of Frankfort, Severance Burrage of Lafayette, and Elkanah Hulley of Marion; permanent Secretary-Treasurer, Frank C. Jordan, Indianapolis.

In his presidential address, Mr. H. E. Barnard took occasion to praise the Indiana law forbidding stream pollution and closed with a plea that the problems of filtration and sewerage systems be left to competent commissions rather than to popular vote. Mr. Edward Bartow in his paper on "Water Softening" gave the estimated cost of softening the water of the White and Wabash rivers as about $12 per 1,000,000 gals. The problem of the falling ground-water level in Indiana was discussed in a paper by Mr. Chas. Brossman, some portions of which will be reprinted in abstract in a future issue of Engineering News.

Dr. J. N. Hurty, in connection with his paper on "Progress in Stream Pollution Elimination," called attention to the present objectionable condition of the Ohio River, of which he said, in part:

> The Ohio River drains an area twice as large as the area of England and gathers in so doing the surface filth of scores of cities, the sewage of one million people and the refuse of many a large packing house. At one time Cincinnati used that water and paid her toll in deaths. Now that the Cincinnati filtration plant has been installed, the typhoid death rate has dropped to one-fourth of what it was a few years ago.

Mr. John W. Alvord and Mr. Howard A. Dill read papers on water-works valuations at the banquet on the evening of Feb. 26. There was some discussion regarding the respective valuations to be placed upon "good will" and "a going concern." Mr. Alvord's paper is reprinted elsewhere in this issue.

A partial list of the papers presented at this meeting was published in our issue of Feb. 10.